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Making Non-Ferrous Castings in a Railroad Shop

Practice Pursued in the Foundry Operated by the Pennsylvania Railroad Co., at Altoona, Pa.—Production of Large Aluminum Doors

By E L Shaner

MANUFACTURERS continually are demanding greater skill and ingenuity from the producers of non-ferrous metal castings and in order to keep abreast of the times, the modern brass foundry must be equipped with facilities for carrying on a large amount of costly experimental work. The knowledge and experience gained in such preliminary investigations form a basis for the satisfactory and successful production of castings. Perhaps the frequency with which new designs are brought to the foundryman for execution reaches a maximum in the non-ferrous department of a modern railroad. For this reason, the practice of the brass foundry of the Pennsylvania railroad at Altoona, Pa., furnishes an excellent ex-

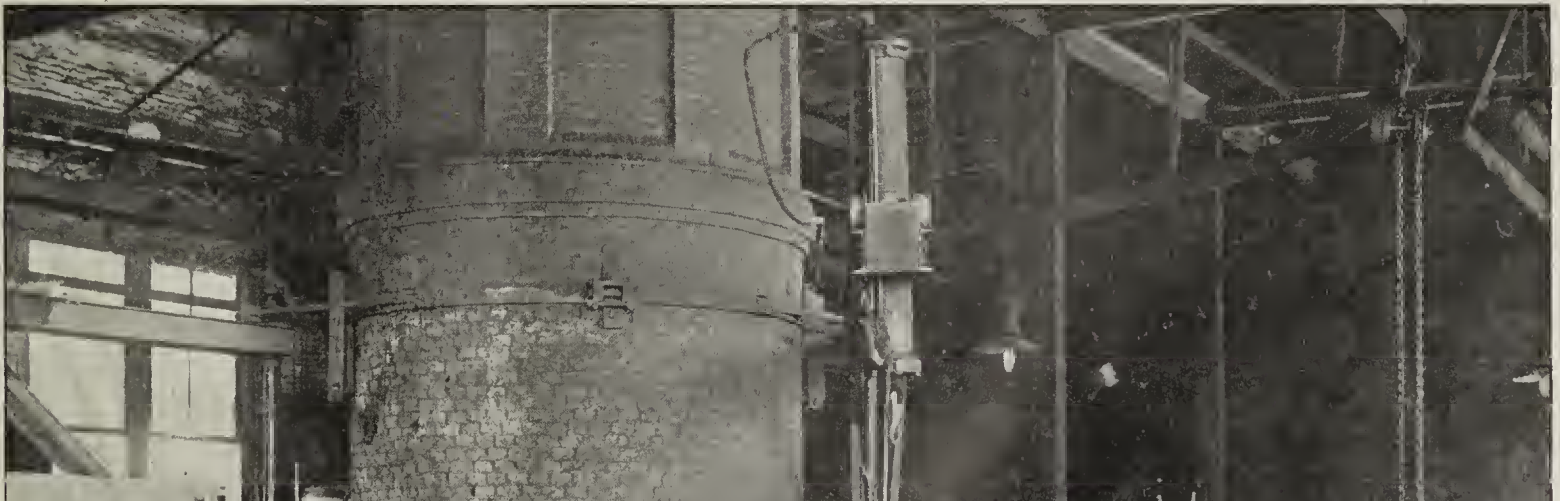

FIG. 1—CIRCULAR BATTERY OF 22 PIT FURNACES IN WHICH NO. 300 CRUCIBLES ARE USED

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ample of what may be accomplished in meeting satisfactorily a constant demand for castings of complicated design, involving the solution of unusual molding and coremaking problems. The Altoona plant is called upon to furnish practically all the brass castings, journal bearings, metallic and other non-ferrous metal appliances for all cars, locomotives and miscellaneous equipment operating on the Pennsylvania lines east of Pittsburgh. The foundry is in operation 24 hours each day and to supply the demand, a daily output of 30 tons of non-ferrous castings is maintained. In addition to this, about 12 tons of white metal are cast in ingot form daily, and an average of about 20 tons of copper are poured each month. Built years ago when the production of most of the brass castings used on the railroad was left to private manufacturers, the foundry buildings are exceedingly small for the amount of work that is now being carried on within their walls. The principal building, which is about 50 x 100 feet, is of wood and brick construction. Approximately one-third of the floor area is devoted to the melting equipment, which is situated at the north end of the building. The molding machines, pouring floor and pattern plate storage racks occupy the central and south portions of the structure. The storage rooms for old material, patterns and ingot metal, and the finishing and cleaning departments, core room, etc., are in buildings grouped around the main foundry structure. One of the most complex foundry problems yet encountered at the Altoona plant was introduced when an attempt first was made to cast thin aluminum doors for steel passenger coaches. When a few railroads of the country first designed all-steel passenger cars it was only natural that steel sheets were specified for the doors to conform with the sheets and plates used in the general construction of the car. After a few years of service it was discovered that the steel doors were deteriorating much faster than other parts of the car, and upon investigation it developed that condensation formed on the inside of the sheets. This of course caused rust to accumulate rapidly between the walls of the door, and in at least one instance, a quart of water was drained from a door through a hole that had been drilled in the bottom for purposes of inves-

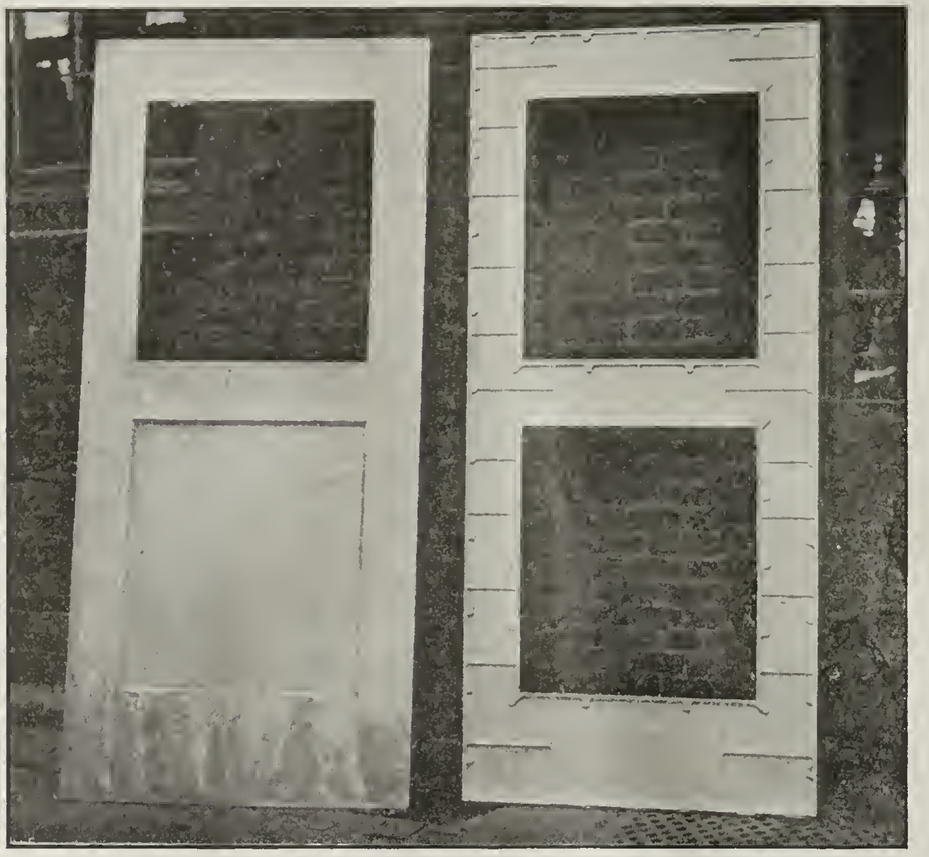

FIG. 2—THE TWO SECTIONS OF A CAST ALUMINUM DOOR FOR A STEEL PASSENGER CAR

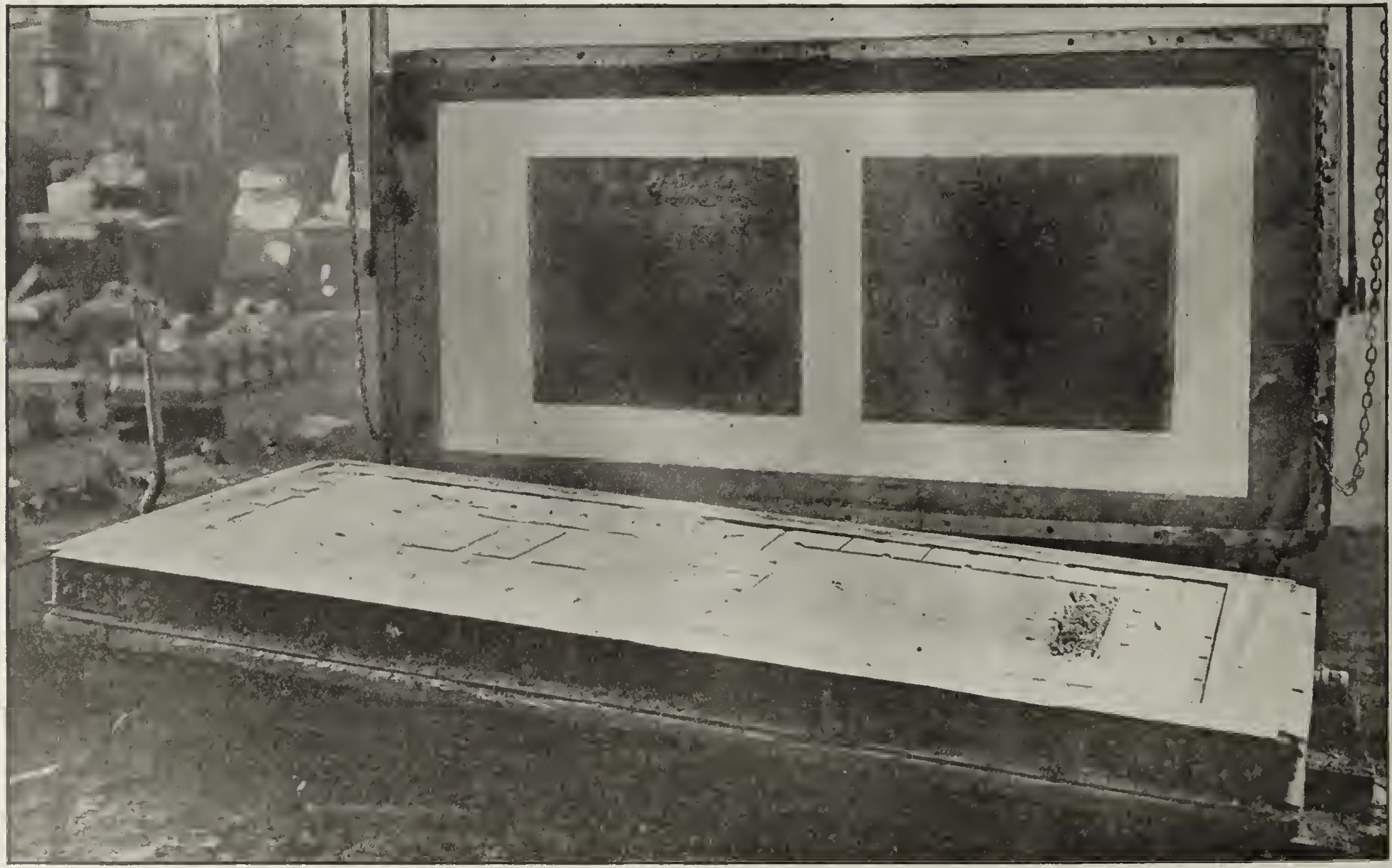

FIG. 3—COPE AND DRAG OF MOLD FOR ALUMINUM DOOR

tigation. Some difficulty was also experienced with steel doors because of their tendency to warp. Railroad officials turned to the aluminum door because of its light yet strong construction, its resistance to rust and the ease with which it can be converted to other uses if distorted in a wreck or replaced by a door of later design. The first attempts of the Altoona foundrymen to make suitable door castings met with varying success. Cracks in unexpected places, warped sections and innumerable other difficulties were encountered. As experience was gained from the results of each succeeding effort, the design of the casting, the analysis of the metal, and the method of casting were in turn gradually modified until now, the proportion of list castings is very low. The two parts of the door as they appear when ready for the machine shop are shown in Fig. 2. It will be noted that one section is merely a frame for the window glass and for the thin panel which is cast as part of the other section. When the two sections are bolted together, the door is 1¼ inches thick, about 37 inches wide and 7 feet long. It contains about 107 pounds of aluminum.

The patterns for the door castings are aluminum, carefully machined to a size that will allow for the proper amount of shrinkage. Since the length of the casting is reduced approximately 1⅜ inches is cooling, and since the metal is only from ⅛ to 3/16-inch thick, except at the lugs for the bolt holes, it will be readily appreciated that the preparation of a suitable pattern is attended with considerable difficulty. Moreover, the fine molding and beading at the edges of the panels must be accurately formed so that a perfect reproduction may be obtained in the casting. The finished cope and drag of the mold for the lighter section of the door are shown in Fig. 3. It will be noted that the drag is placed in an inclined position, and that the heavier end of the casting is placed at the upper end of the mold. Every precaution must be taken to prevent uneven stresses arising from the shrinking of the metal when cooling. To assist in accomplishing this, chills are used extensively throughout all parts of the mold. A careful examination of Fig. 2 will reveal the

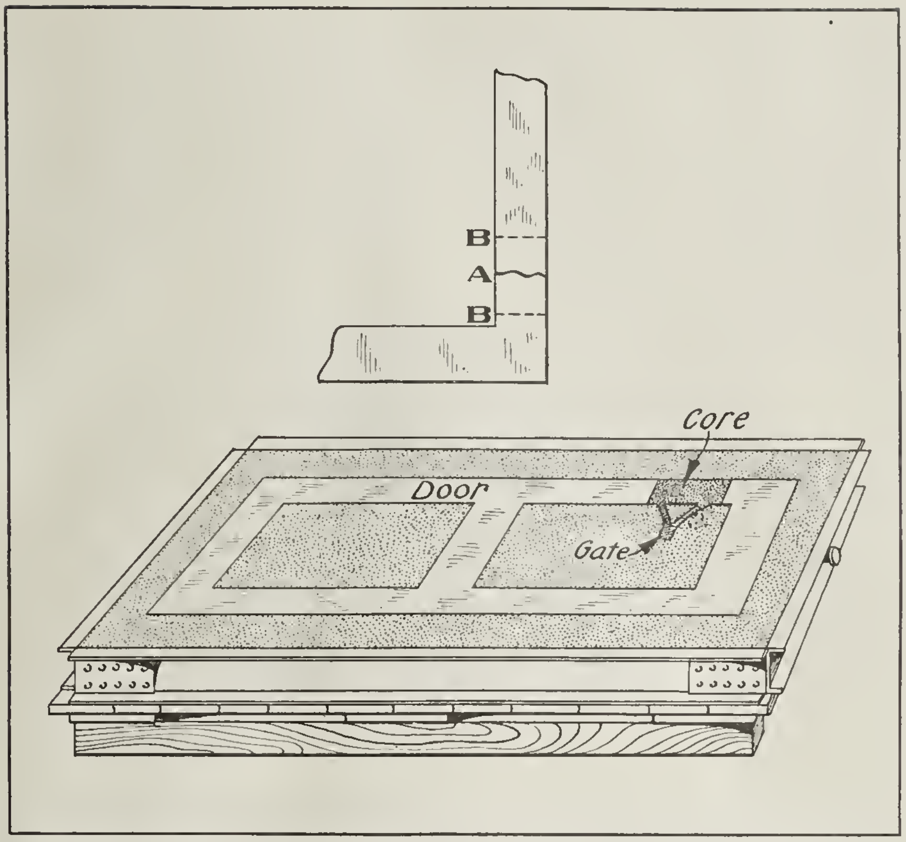

FIG. 4—SKETCH SHOWING HOW DEFECTIVE DOOR CASTINGS ARE REPAIRED

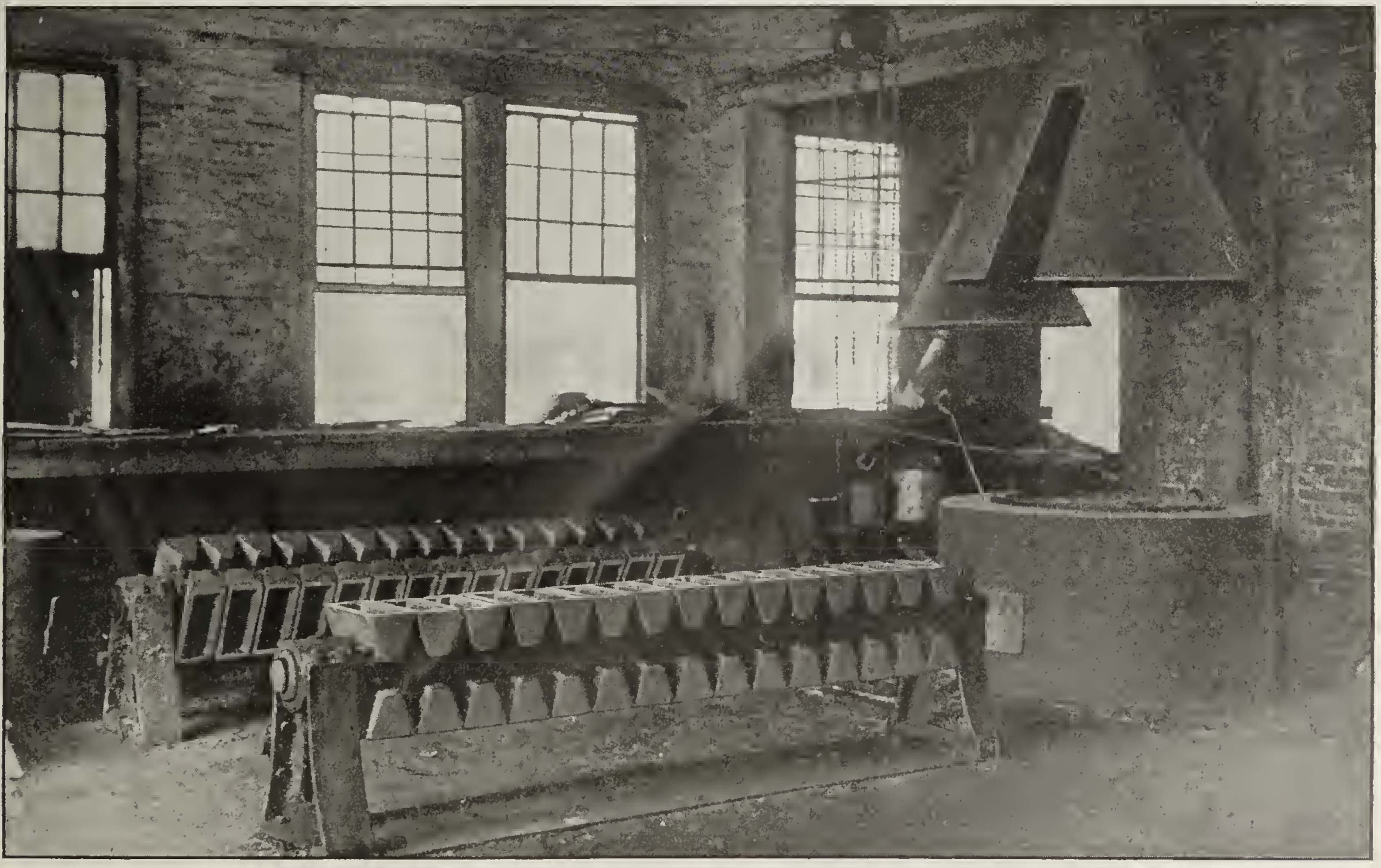

FIG. 5—A MACHINE IN WHICH OLD METAL IS CAST INTO PIG FORM

imprints of several chills, which in most cases are inserted in the mold at the middle point of each reinforcing rib of the door frame. About 70 chills are required for each casting. The sand at the opening for the window glass, located in the lower part of the mold, is cut away and loosened, as indicated in Fig. 3, so that the end section of the door will have an opportunity to move freely when the contraction of the metal begins.

The metal is poured from two ladles simultaneously into gates at each corner at the upper end of the mold. As shown in the view of the drag the feeders from the gates are comparatively large so as to provide an ample supply of hot metal while the mold is being filled. The presence of two heavy gates in the firmly packed cope would tend to hold the upper part of the casting stationary in the mold, and would necessitate the movement of the lower part of the casting toward the top through a distance equal to the total shrinkage length of the casting. To overcome this difficulty, a small opening leading to the lower part of each gate is provided, and when the hot metal begins to back up from the filled mold into the pouring basin, the plugs in these openings are removed, allowing the excess metal to be drained from the gates. This method permits the gates to perform their proper function while the metal is being poured but eliminates the disastrous strains caused by the uneven cooling of the metal in the thin casting and in the comparatively heavy gate. It also assists in equalizing the shrinkage movement in all parts of the mold.

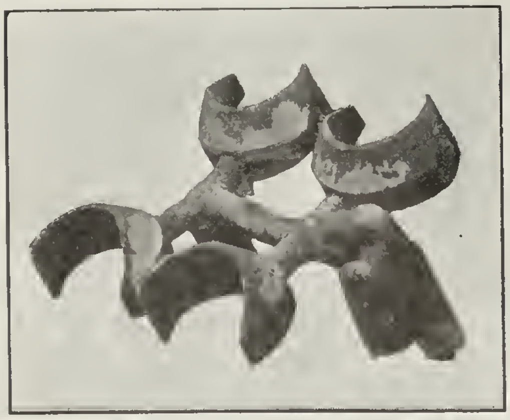
FIG. 6—TWO SETS OF METALLIC PACKING RINGS SHOWING ARRANGEMENT OF GATES AND RISERS

The door casting is so thin in many points that it is extremely important that the cope and drag be placed together properly, and that all opposite faces of the mold are equidistant from each other. To insure this, two heavy rails are placed lengthwise over the cope directly above two similar rails which are under the drag. These are clamped together in the usual manner, and in addition several bolts are slipped through holes previously made in the mold at the centers of the openings of the door frame. These bolts engage a threaded clamp plate under the bottom pair of rails and when they have been turned up tight, the two parts of the mold are brought together against two stops which maintain the proper distance between the faces of the cope and the drag.

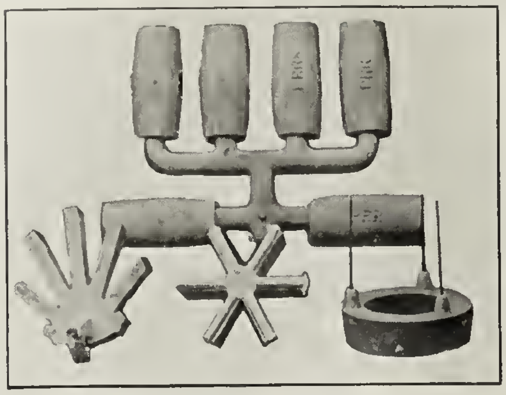
FIG. 7—BATTERY ZINCS AND HEADS FOR SOFT HAMMERS

Patching a Broken Casting

In spite of the precautions that are taken to prevent shrinkage troubles, broken castings are occasionally taken from the molds. When the making of aluminum doors was still in the experimental stage, all defective castings were melted and the metal used a second time. At the present time, however, unless the casting has an unusually great number of imperfections, an effort is made to repair it. Practically all of the castings which develop cracks have a simple fracture through a section of the frame, as indicated at *A* in Fig. 4. In the case of a break of this kind, the section included between the dotted lines, *BB*, is sawed out of the casting. A core as near the shape and size of the section as possible is then made, and after the casting has been rammed up in the drag as if it were a pattern, the sand is cut away so that the core may take the place of the broken section that was removed. The cope is then put in place, the sand rammed, and the two parts of the mold are separated to remove the core. A gate is cut in the cope, and the mold is assembled for pouring. If the work has been carefully done, the new section will be neatly formed, and after it has been cleaned and the few irregularities ground off, it is difficult to distinguish the old section from the new.

The casting of the half-ring sections of metallic packing shown in Fig. 6 was a source of considerable trouble when the work was first attempted. Aside from the difficulties arising from the sweating of the lead in the mixture, considerable loss resulted from the presence of sand and dirt in the finished casting. The sweating was overcome by a change in the method of molding, but clean castings were not obtained until the skim gate was used in all molds. The method of gating and heading these castings is shown in Fig. 6. The output of metallic packing rings at Altoona amounts to 200 sets per day, and under the present methods, the number of defective castings has been reduced to a remarkably low figure.

A large number of miscellaneous castings are included in the daily output of the plant. In each case, where a difficult casting has been brought to a satisfactory point, the achievement has been the result of tedious experimental work. The testing department of the Pennsylvania company assists the foundrymen in working out many of the problems with which they are confronted. At the present time, representatives of the testing department are co-operating with the management of the foundry in an effort to secure better check valve castings. This particular casting has comparatively thin walls which must be sufficiently strong and solid to withstand high steam pressures. While the practice of molding and pouring is being modified in the foundry to improve the casting, the testing department is making tests of the product to ascertain what improvement has been made. Under this system, many important devices have been developed without having been subjected to road service where failure might have caused detentions to trains. Figs. 7, 8 and 9 indicate to some extent the variety of the castings made at the brass foundry at Altoona.

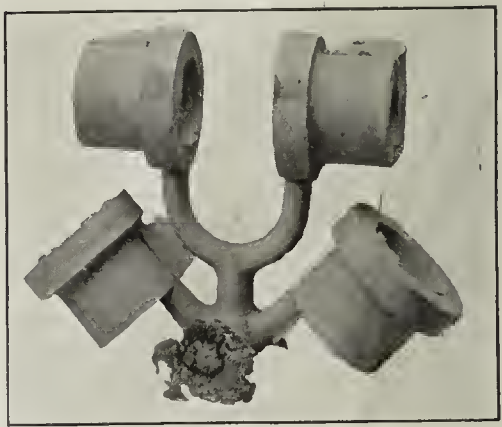
FIG. 8—A GROUP OF FOUR BRASS CASTINGS SHOWING METHOD OF GATING

Most of the molds are made on

Tabor or Mumford molding machines. Eight of these machines, devoted exclusively to making molds for journal bearings, are arranged in a row traversing the center of the building. Near the south wall are two 24 x 30-inch Tabor machines which are used for making molds for driving box shoes, wedges and liners. Two other Tabor machines, situated in the south end of the foundry, are employed for making molds for a great variety of small brass castings. A number of the larger castings require heavy molds which are made up on the floor by hand.

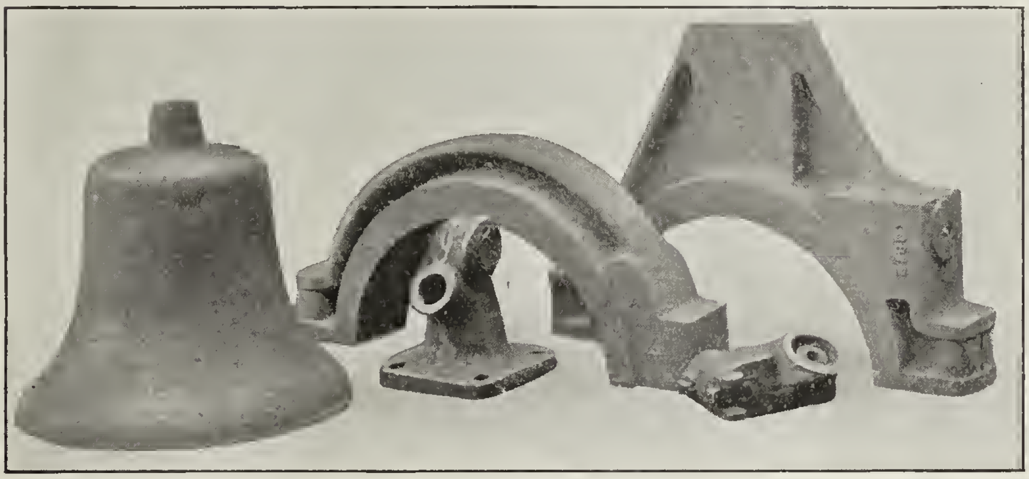

FIG. 9—A LOCOMOTIVE BELL, ECCENTRIC STRAP, AND OTHER CASTINGS FOR LOCOMOTIVES

Practically all of the patterns and pattern plates are made of brass or aluminum. The small patterns, mounted on 12 x 16-inch plates, are stored in a large rack at the south end of the building. The Pennsylvania system of numbering patterns, in which the letter prefixed to the number denotes the service in which the casting is used, permits a convenient arrangement of the patterns in the racks, so that they may easily be found at any time. Large patterns, and those which are not frequently used, are stored in a building adjacent to the foundry. All castings weighing less than 110 pounds are cleaned in a rumbling mill and the larger pieces are cleaned by means of pneumatic hammers. In the same building containing the cleaning room is a department devoted to the boring and lining of journal bearings. The equipment consists of a number of melting furnaces and four machines for boring new bearings and re-boring old bearings after lining metal has been melted out. These machines are arranged to bore four bearings at one time. The bearings are held in position by a pneumatic clamp mounted on a carriage, which travels on horizontal guides, a sufficient distance to bore the length of the bearings. Old bearings are thrown into a lining metal pot in which the old lining is melted off. The bearings are then inspected; those that are fit for further service are rebored and relined while those not fit for further service are melted and made into new bearings. After boring, the bearings are heated, treated with sal-ammoniac, dipped in a tin bath, and then placed on a mandrel that acts as a mold for the new lining metal. The meltiing equipment at the Altoona brass foundry consists of 33 pit furnaces and two Piatt furnaces. Twenty-two of the pit furnaces are arranged in a circle around a single stack, as shown in Fig. 1. No. 300 crucibles are used, and at present coke is used for fuel. Work has been started on the task of gradually changing from coke to natural gas, and it is expected that the output of the plant will not be affected while the change is being made. A representative of the Peoples Natural Gas Co., Pittsburgh, who is directing the installation of the natural gas system expects that the cost of fuel will be diminished, that the time of the heats will be reduced, and that the life of the crucibles will be prolonged by the introduction of gas as fuel.

The other 11 pit furnaces are situated in a row at the north end of the building. Various sizes of small crucibles are used in the pits in this battery. The two Piatt furnaces, in which most of the metal that goes into the larger castings is melted, are in the northwest corner of the foundry. It has been decided to change at least one of these furnaces from a coke-fired to a gas-fired unit, and to accomplish this, it has been necessary to devise a method of adapting a burner to the tilting motion of the furnace. A flexible pipe arrangement was first suggested, but for various reasons it was dropped, and in its stead, a design for a stationary burner, with a sliding sleeve which automatically confines the flame while the furnace is being tilted, has been adopted.

A building east of the foundry is devoted to the storage and reclamation of scrap non-ferrous metals. A description of the methods employed by the Pennsylvania Railroad Co. in recovering old metals appeared in the June issue of *The Foundry*. One of the interesting features of the reclamation process is the labor-saving device which has been introduced to simplify the handling of pigs of reclamed metal. Metal which has been melted in the furnace shown at the right in Fig. 5 is poured in one of the casting machines at the left of the illustration. When all of the molds on one side have been filled, a lock which holds the molds in position is released, and the shaft is turned so that the unfilled molds come to the top for refilling. This simple contrivance has eliminated the labor previously involved in lifting out each pig by hand.

Shrinkage and Contraction

By H. J. McCaslin

There appears to be a difference of opinion among foundrymen as to what is meant by the terms shrinkage and contraction. Some time ago I read in a trade paper this explanation of the difference between the two. In the transition of nearly all commercial metals by heat from the solid to the liquid state, they expand, the reverse action taking place during cooling. While the metal is in the liquid state this decrease in volume action is termed contraction. But from the moment of solidification, it is technically known as shrinkage.

We find pattern rules made by one company marked shrink rules and by another, contraction rules. If there is a difference between the two terms as applied to the melting of metal, this is the way it appears to me.

Shrink heads are placed upon a mold to feed it during the process of solidification. Shrinkage checks or ruptures often appear at the intersection of members of a casting, which frequently are eliminated by the use of chills. Sponginess occurs in the interior of heavy castings caused, as I understand it, by the metal shrinking away from the center toward the outer walls which solidify first, if not properly fed by a shrink-head or riser.

It seems to me if we are to differentiate between shrinkage and contraction, shrinkage would mean the changing of the structure of metal in its transition from the liquid to solid state, contraction being the amount the casting has decreased in size when it has reached normal temperature.

How Profit-Sharing Has Worked in Foundries

Every Phase of This Alluring Subject is Discussed and Reasons Why Some Methods Have Not Been Successful Are Pointed Out

By C E Knoeppel

IN ALL of our discussions of the important question of industrial preparedness, there has been little said with reference to *adequate incentives.* In an address before the Academy of Political Science of New York on "Compulsory Service and Industrial Preparedness", I stated that compulsory service ceases to be compulsory when there is a desire and a willingness to serve and that our problem was to find out how to induce this willingness and desire. Likewise in industrial activities, this willingness and desire must be induced—*it cannot be forced*—and to do this, incentives in some form must be devised and provided.

A worker laughs when he hears someone speak of the joy of work. In business, however, men will work for 16 hours a day if it is found necessary. For the love of the game? Yes, to some extent because to play the game is essential to success, but the real reason is the incentives behind it all, warranting concentration and hard work for long hours.

A worker goes home at night and he has earned a day's wages. Tomorrow is another day and he will earn another day's wages—if he is not discharged or laid off; if he does not quit; if he does not die or is not taken sick. His life is a by-the-day proposition. Of course this is conducive to freedom from worry, contentment, and an optimistic attitude and the like. On the other hand, the business man or executive goes home at night knowing that tomorrow, next week, next year, he has something to work for—*his business.* He may be worried because of business conditions; things may not be breaking just right but he feels that this is all part of the game and that he is playing with what is actually his.

No, I am not a Socialist. I am not advocating an equal distribution of things, nor a giving away of anything that isn't warranted by the conditions. I am simply trying to picture the difference between incentives and the lack of them.

In industry the manufactured product, in the last analysis, is labor, for the material that is bought by one concern and processed by labor, represents the labor spent on other material by another concern, and so on through to basic processes. With this thought in mind it should stand to reason that the man who serves his employer best is the one—

1—Who works efficiently rather than strenuously.
2—Who is not forced nor driven.
3—Who has faith in the management.
4—Who is not treated in the manner that induces worry and doubt regarding the future.
5—Who does not have to shoulder responsibility that rightly belongs to the management.
6—Who knows that the question of exertion and fatigue receives due consideration by the management.
7—Who works under the right working conditions.
8—Who realizes that the management is interested in his welfare.
9—Who works in a pleasant, congenial atmosphere.
10—Who receives something in addition to wages for time spent at work, which represents, to him, his skill, cooperation and extra efforts.

These are real incentives and until the time comes when they are all provided, there will not be the right relationship between capital and labor.

Business Conducted for Profit

Business is conducted for profit. Material is purchased and brains and muscle are utilized in converting this material through the medium of plant and equipment, into a finished product at a cost that will be less than the price secured. The material, plant and equipment represent an investment. Inasmuch as it is impossible to get results from the capital investment without the human investment, these conclusions seem logical:

1—That capital investment is entitled to a fair return on the amount invested, in the form of interest for the use of money.
2—That brains and muscles are entitled to a fair return for the efforts expended, in the form of salaries and wages.
3—That after the capital and the human investments have received their fair returns, the balance, after providing for contingencies, depreciation, bad debts and the like, should be divided between both capital and human investments, on some basis that represents the reward for results, both investments were instrumental in securing.

You say this means profit-sharing. Let us look at it as savings-sharing, for profit-sharing on the right basis should induce the desire to effect savings which would be divided between capital and human investments.

You say, "Suppose there are no profits or savings to divide?" My answer is that proper methods and the desire to share in the savings will, in the majority of cases, lead to savings to share.

Let us not look at this subject, however, without considering the thorny side of things. In a survey made by the welfare department of the National Civic Federation, it was found that of the companies whose plans were analyzed, *almost one-third were successful and the balance failures,* which would seem to indicate that no further thought should be given to the matter.

Let me paint you a few pictures before passing judgment, in an effort to determine a real basis for profit-sharing.

Two molders are working side by side, each drawing the same wages, we will say, and both in the employ of the company for about the same length of time. One of them is a careful, painstaking and conscientious man, who gives his employer the best he has, his contribution being maximum production with a minimum of rejections. The other is not so careful nor painstaking, nor conscientious, putting up only enough work each day to get by and while having scrap from day to day, does not have so much as to cause his dismissal. The one displays interest in his work. The other doesn't. The one does his best; the other believes in doing no more than he has to. Dividing profits or savings between these men gives them an equal amount and the effect is detrimental to both. The conscientious man smarts under what he feels is an injustice in that he gets no more than the other man, for even though he says nothing about it, he knows in his own heart that he has earned more for the company than the other and consequently feels that his share should be greater. The man not so conscientious knows that he has, without exerting himself, to the same extent as his fellow workman, secured as much in the sharing, and naturally feels that there is no need for him to do his best. The result is that both say—"What's the use?" This establishes

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A paper presented at the annual meeting of the American Foundrymen's Association, Cleveland, Sept. 11 to 15, 1916.

an important law as I see things—*sharing in savings or in profits should be in proportion to individual attainment.*

Now for another point. The worker is a by-the-day thinker, for all his life he has worked from day to day, getting his money from week to week or twice each month. He lives in the immediate as far as his work life is concerned. The purpose of saving or profit-sharing is to induce interest, foster a desire to do the best that is possible and to get the worker to take every advantage of his opportunities and the facilities furnished him. People are prone to count their chickens before they are hatched but if the hatching is too far in the future, they quit counting. So with workers. They will work for savings or profits if the division is more or less immediate, but if you attempt to keep them interested on the basis of promises that will not materialize for six months, you will find their interest on the wane and again the result is—"What's the use?" This establishes another law—*profits or savings should be shared at such frequent intervals as will insure interest being maintained.*

Earnings Not Essential to Plan

Another point has a bearing on this important question. Men are working under a profit-sharing plan. They are expecting that there will be profits to divide and then, we will say, due to a bad year the earnings are insufficient to warrant sharing them with the workers. Now imagine the feeling of a worker trying to do his best, realizing that he has given his employer the best of service which should, as he sees things, entitle him to something above his wages, suddenly confronted with the situation which he expresses as "nothing doing". Again the result is —"What's the use?" This situation, to my mind, establishes still another law—*something should be given to the worker regardless of the company showing in return for the interest and effort expended in anticipation of sharing in profits.*

What's the Use?

Still another point. Workers may share in the profits or savings made, but if they see evidences of extravagance, of carelessness, of waste on the part of the management; of factors they cannot control like bad debts, buying at high prices due to faulty purchasing, faulty selling, inefficient equipment, poor working conditions, faulty methods, you are confronted with the same condition —"What's the use?" This establishes the fourth law—*savings or profit-sharing should be on the basis of factors within the workers' control.*

There are, of course, other points that can easily contribute to the failure of a plan of profit or savings-sharing, as for instance—

1—The attitude of organized labor.

2—The fear of over-production and the introduction of machinery.

3—Suspicion on the part of labor as regards motives and intent.

4—Failure to properly understand the plan in use.

5—No say in determining the plan by labor.

6—No way of determining that the profits are as stated by the management.

I believe, however, that if the four laws are recognized and lived up to, the plan that may be decided upon can be made successful in the majority of cases.

Let us restate these four laws and see what can be done towards working out a plan based on a conformance to them:

1—Sharing should be in proportion to individual attainment.

2—Frequent intervals in dividing.

3—Division regardless of company showing.

4—Division should be on items within the workers' control.

But you say—how are we to determine individual attainments? How can we divide savings or profits when we only know once or twice a year what our real condition is? If we suffer a loss we have to stand it, why shouldn't the men? Why should we give men a division on items only within their control, when our real showing is on all the items which influence profits and savings?

These are fair questions and demand consideration. In attempting to do this let me give you a fundamental principle:

Unless the plan you establish is based on right and justice; unless there is something of the give and take to it; unless there is co-operation between the men and the management in working things out; unless the men can feel that they have some say in it all, by all means save your energy and your money, for unless this fundamental is considered, the plan is doomed to be a failure before it is even put in operation. Remember that two-thirds of the plans have proved failures and what you install must be on such a basis as will insure success at the outset.

Let us consider the laws in logical order:

Much has been written and said about individual attainment, but I contend and my experience has shown that standards can be set that will determine the efficiency of each man, such as molder or coremaker, or groups of men, such as cleaners or laborers. Where they cannot be accurately or scientifically set, fair estimates can be made, not by looking at a pattern and saying, "Oh, this will take about five hours," but by setting down the known elements and estimating the time for each element as indicated by the following:

OPERATION	ESTIMATED TIME, MINUTES
Laying board and pattern.	
Placing drag.	
Riddling sand.	
Shoveling heap sand.	
Ramming drag.	
Laying bottom-board.	
Clamping and rolling.	
Placing cope side of pattern.	
Placing cope.	
Placing gaggers.	
Ramming cope.	
Lifting cope.	
Finishing mold.	
Filing, setting and securing cores.	
Closing.	
Clamping and placing weights.	
Total allowance.	
Grand total.	

It is obvious that a concern that does not known its exact condition until the end of a year, cannot, of course, divide savings or profits at frequent intervals during the year. The fact remains, however, that the accounting and cost systems can and should be arranged on the basis that would enable the management to secure monthly profit and loss statements, from which it could be determined what had been saved in reduced costs or made in profits. Even if no monthly payment was made to the men they could be advised regarding the showing, along with an idea regarding what they would make and the payment made every three months, or at least twice each year. The knowledge that they had earned something with an idea regarding the amount would do much to keep the interest of the men at the right point.

Rewards Regardless of Company Showing

It wants to be remembered that all the men have to look forward to is their wages, which they, of course, receive regardless of any loss the company may sustain. At the same time the owners of the company have the future to look forward to. They own the business, the investment is theirs and losses sustained at one time may be made up at another time. They can borrow money; the men cannot. They may have a surplus. The men haven't. They may have a reserve capital which the men do not possess. After all, the big thing is to secure the co-operation of the men and a striving for rewards and their not getting them will do more than any other one thing to make them lose heart and say—"What's the use?" Some provision should be made to let the men share in some form of reward, regardless of the company showing.

You can well imagine the effect on the average worker's mind, of doing sufficiently well on things within his control to entitle him to rewards only to lose them because of what happens to items not within his control. The men can't and should not run a business. They are engaged to do certain definite things and the idea of giving them a share in savings or profits is to get them to do their best with reference to these certain, definite things. The men might do their part of the work, but because of poor purchasing, or inaccurate costing, or other causes, losses would wipe out the gains the men ought to make. It seems, because the men are not to blame for the losses and because they have done what would otherwise entitle them to rewards on the items they could and did control, that they should be rewarded.

Some years ago in a shop paying their men on the bonus plan, some men were delayed, due to causes beyond their control. The time set, we will say, was 10 hours, and that the men did their part of it in 10 hours, but because of the delays of two hours the total time was 12 hours, or an efficiency of 83.3 per cent. Should the men stand this delay or should they receive their reward and the inefficiency be charged to the management?

Suggested Plan

Under any plan of profit or savings-sharing, the regular wages paid to the men in the district should be paid to the men working under the plan.

To base the rewards on individual attainment, fair standards should be determined by motion study or estimates based on detailed analysis and a sliding scale should be paid the men over and above their wages based on their attainment as follows:

Per cent efficiency.	Per cent on wages.
100	20
90	10
80	5
70	2
60	0

As this premium would be paid on what the men actually do, rewarding them as outlined, would take care of the two provisions, rewarding them on items within their control and regardless of the company showing.

After rewarding the men as outlined and after taking care of depreciation, bad debts and reserves and giving capital investment a fair return on the money invested, the balance should be divided between the capital and labor investment. *The amount to be given the men should be paid on wages plus premium.*

If you pay men wages, plus premium or bonus based on individual attainment and on top of this give them an additional amount representing their share of savings or profits, *you have provided real incentives;* for men will then be anxious to do their best, because high efficiency will result in increased wages. Increased wages will mean larger premiums and a large wage and premium total will mean a greater share on the savings or profits.

In arranging to distribute savings the following could be used to advantage:

Divide the business into departments and charge them with the direct labor costs, indirect labor costs and the proper share of overhead expenses, chargeable to the producing end of the business. Credit these departments either with what the costs were at the time the plan was started, or with fair estimates covering the work done from the standards determined upon. This means that the departments would be charged with actual times or costs and credited with estimated or standard times or costs. The difference would be the savings or waste. Incidentally, the men should have some say in the settling of these estimates or standards if their full and hearty co-operation is to be secured. In case piecework was in operation at the time the plan was introduced, which would naturally have to give way to an hourly base of wage paying, the pieceworkers could be paid out of the savings, the difference between the day rate and what their hourly rate on piecework was for a period of four to six months previous to the installation of this method of reward.

Other Plans

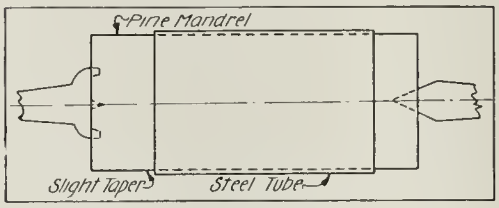
As can be seen, this, with reference to the business as a whole, is the same kind of a plan as applies to the men in giving them a premium or bonus based on individual attainment. The total actual and standard or estimated times and costs covering all the molders would be the charge and credit for the molding department and the difference would be the waste or saving. The total actual and standard or estimated times of all departments would give the charges and credits for the business as a whole and the difference would be the waste or saving. One-third to one-half of the net savings should be credited to the men and paid to them on the basis of total wage and premium earnings, as before mentioned. Common labor and the foremen should be included in the division. Another plan would be, after capital has received its legitimate earnings and taken care of contingencies and labor has received its regular wages, any surplus should be divided between the two *in proportion to the earnings made by capital and labor.* If in a business capitalized at $500,000, the earnings amounted to $100,000 in a year and the earnings of labor were $100,000, any surplus should be divided—fifty-fifty—as the saying goes. In other words, after deducting 6 per cent as dividends, $30,000 and $25,000 for contingencies, reserves, etc., or $55,000, the surplus would be $45,000, of which $22,500 would go to labor and $22,500 to capital.

Other plans could be described, and details outlined, in fact a good sized book could easily be written about profit-sharing. After all, the principles cover far more than methods. If the principles are right, the methods cannot go very far wrong.

Improved Sanding Roll for the Patternmaker's Lathe

By S. L. Cook

In most shops sanding rollers for use in the lathe are sometimes indispensable, especially when getting out gear teeth and similar duplicate work. In making the wooden roller with either the sand paper glued to it directly or held in place with a thin stick, a few undesirable features disappear when using a roller of the following description: The paper is glued to a piece of steel tubing of the required length and diameter, having about 1/32 or 3/64-inch wall.



AN IMPROVED SANDING ROLL FOR THE LATHE

A pine mandrel is turned to fit the tube so that it fits tight. If the mandrel is tapered perceptibly for about an inch from the end where the driving center fits, the tube will hold nicely.

To remove the sand paper and to apply a new strip, tie a string to the tube and drop it into the hot water of the glue tank and the paper will soon slip off easily. In applying new paper, fit the paper to the roller or tube so that the joint butts together. In fitting the paper, slightly moisten the back, thus preventing the paper from cracking. Apply thin glue to the tube, put on the paper and wind some string around it to keep it in place.

By having two rollers of the same size, but with different grades of paper, one can be used for roughing and one for finishing.

S. Cheney & Son, Manlius, N. Y., celebrated the 50th anniversary of the establishment of its foundry in December, by opening a branch casting plant at Oneida, N. Y. The company was established in 1866.

A Cost System for a Small Malleable Foundry

How Results Can Be Obtained With a Low Percentage of Probable Error and at a Low Expense for Additional Clerical Help

By Federick C Moore

THE cost system outlined in this article was laid out to give results with a low percentage of probable error with a minimum of additional clerical expense. It is believed the system is sufficiently accurate for the guidance of the management and operating organization of a small malleable foundry. As far as possible, the figures are taken directly from the office books of account, and from the day to day records of the pay-roll and the shop. The forms are such as can be handled readily by the average foundry office clerk or time-keeper. The final record is built up in the manager's office.

The preliminary monthly average cost per ton is worked up along standard lines. All expenditures for the month are summed up in a grand total. This total, divided by the weight of good soft castings produced for the month, gives the average cost per ton for the month.

The two forms shown in Figs. 1 and 2 are used for the purpose of working up this preliminary report. On the blank form shown in Fig. 1 are entered all the items covering metal charged into the furnace, with as much detail as may be desired. The cost of metal entering into the good castings made for the month is worked out by the ordinary method, balancing the costs of metal charged into the furnace for the period against the actual product and by-product recovered. If annealing pots are poured from the regular heats, it is best to deduct the tonnage taken from the spout to the pots. This item may then be used as the basis for a pot cost and pot manufacture treated as an entirely separate part of the business. Deducting the pot tonnage gives the cost of the net charge going into regular manufacture. This total amount must be accounted for in the metal realized from the pour, in the shape of good castings, bad castings, hard and soft scrap, etc. This division of values is made on the form shown in Fig. 2. On this blank are entered the weight of sprue made and the weight of all other items such as shot, ladle spill, hard and soft scrap, etc. The weight of salable castings produced is also entered. The difference between these weights and the weight charged, is the melting loss. The total cost of the charge must be distributed among these items. The scrap items are priced at a nominal figure for this purpose. It is entirely immaterial just what price is used, as long as the same price is used throughout the costs. This material is charged back into the furnace and makes no difference in the cost for the twelve months of the fiscal year, except to the extent to which scrap may have accumulated at the end of the year. For this reason these prices should not be too high. The following scrap prices have been assumed in this article: Hard scrap, $9.00; soft scrap, $10.50.

Cost of Metal for Month of_______1916				
Metal Charged into Furnace				
Item	Per Cent of Total Charge	Weight in Tons	Price Per Ton	Cost
Pig Iron				
Sprue			*9.00*	
Other Hard Scrap Items			*9.00*	
Soft Scrap Items			*10.50*	
Purchased Mall. Scrap				
Steel				
Total Metal Charged				
Less Metal Pots				
Net Charge Applied to Regular Operation				

FIG. 1—FORM USED FOR WORKING OUT PRELIMINARY REPORT

Cost of Metal for Month of_____1916				
Distribution of Metal Charged into Furnace				
Item	Per Cent of Total Charge	Weight in Tons	Price Per Ton	Cost
Sprue Made			*9.00*	
Other Items of Hard Iron Scrap			*9.00*	
Reclaimed Shot, Spill, Etc.				
Soft Scrap			*10.50*	
Salable Soft Good Castings				
Less by Difference				
Total	*100%*			
Same as Net Charge to Regular Operation				

FIG. 2—FORM USED FOR WORKING OUT PRELIMINARY REPORT

After all the hard and soft scrap items have been priced and extended the remainder of the cost of the charge as determined in Fig. 1 is assigned to salable castings, the cost per ton being determined by dividing by the weight of salable soft castings. This is the figure used in building up the preliminary average casting cost report for the month, as shown in Fig. 3.

This average cost per ton per month would probably be sufficient for a foundry working in connection with a manufacturing enterprise which absorbed all, or nearly all, of the output, but the manager of a malleable foundry doing a commercial business must have a closer analysis. He must know which of his contracts are profitable, and which are showing a loss. It is becoming increasingly necessary also, in making quotations on new work, that he should know the actual costs of castings previously made on the same contract, or on a similar class of work. This entails keeping costs of individual contracts. In addition to furnishing experience in making quotations on future business, the individual contract cost also reveals the undesirable contract and permits the organization to concentrate its efforts on reducing the costs of contracts on which a loss is being sustained. These are all vital factors in the operation of a successful foundry.

Separate job costs are made up along exactly the same lines as the monthly average tonnage cost. Each individual cost is built up as though it were the only contract which the shop ran for the month. Other expenditures are distributed to these individual costs, giving a resulting figure which takes into account the labor and material expenditures, and the effect of losses and foundry practice on the cost of that particular contract. The sum of the totals

Cost Per Ton of Good Castings		
Month of______1916		
Salable Good Castings Produced____Net Ton		
Item	Total Value	Cost Per Ton
Metal		
Fuel		
Molding Labor		
Core Labor		
Other Labor		
Supplies		
General Expense		
Cost of Good Castings		

FIG. 3—FORM USED FOR PRELIMINARY AVERAGE CASTING REPORT

The author, Frederick C. Moore, is a consulting engineer, Cleveland.

for all the castings made for a customer is the tonnage cost for the month's operation on this contract. The regular office and shop records of sales, pay-rolls, and weights, generally comprise everything necessary for computing such a cost with the exception of one item, the actual weight of metal poured into the molds. This figure is easily obtained, and, once obtained, is good until the pattern or gating is altered. When the pattern is first run, several molds should be weighed in order to obtain a fair average total weight of iron poured, including castings, runners, gates and sprue. The castings are then broken off from the gates and weighed by themselves. All sand should be carefully cleaned by sand-blasting, if possible, before weighing. In this manner an approximate weight of the total iron poured into the mold, and of the castings from the mold is obtained giving a basis for calculating the percentage of castings realized, to iron poured into the mold. To this figure is added a percentage covering the weight of ladle spill, shot, waste, etc., for the current month. A method of determining this factor will be described shortly. This weight in connection with the monthly production of each casting, gives the tonnage of metal chargeable to each casting. If the weights are carefully taken they will absorb the entire amount of iron charged, within a small percentage. The amount of this unidentified percentage is a rough measure of the accuracy with which the weights have been taken. In this way a closely estimated distribution of the iron poured is obtained, without the necessity of the complicated and expensive division of castings and sprue otherwise necessary to obtain weights.

Average Total Tonnage Cost For Month of ____ 191 ____				
Item	This Month		Last Month	
	Net Tons	Value	Net Tons	Value
Metal Charged *Total Charge Less Pots*	A			
Hard Castings to Packers *Good Soft Castings Plus Shipping*	B			

Tonnage Figures For Prorating to Contract Costs						
Item	This Month			Last Month		
	Amount 1.	Total 2.	Per Ton 3.	Amount	Total	Per Ton
Metal Charged *Value of Charge Divided by A*			C			
Melting Fuel *Value Divided By A*			D			
Soft Iron Expenses *Divide Totals By B*						
Packing and Annealing						
Finishing						
Soft Cleaning						
Pots						
Scale						
Repairs to Annealing Furnace						
Annealing Fuel						
Shipping						
Packages						
Total			F			
Hard Iron Expenses *Divide Totals By A*						
Un-identified Labor *Except Soft Iron*						
Supplies *Except Pots, Packages & Scale*						
General Expense *All Items Not Marked Above*						
Total			G			
For Checking Only						
Molding						
Core Molding						
Total						
Less Value of Remelt						
Hard Defective						
Shipping Room Scrap						
Customer Rejects						
Total *Should Check with Months Report*						

FIG. 4—FORM USED FOR SUBDIVIDING OVERHEAD COSTS

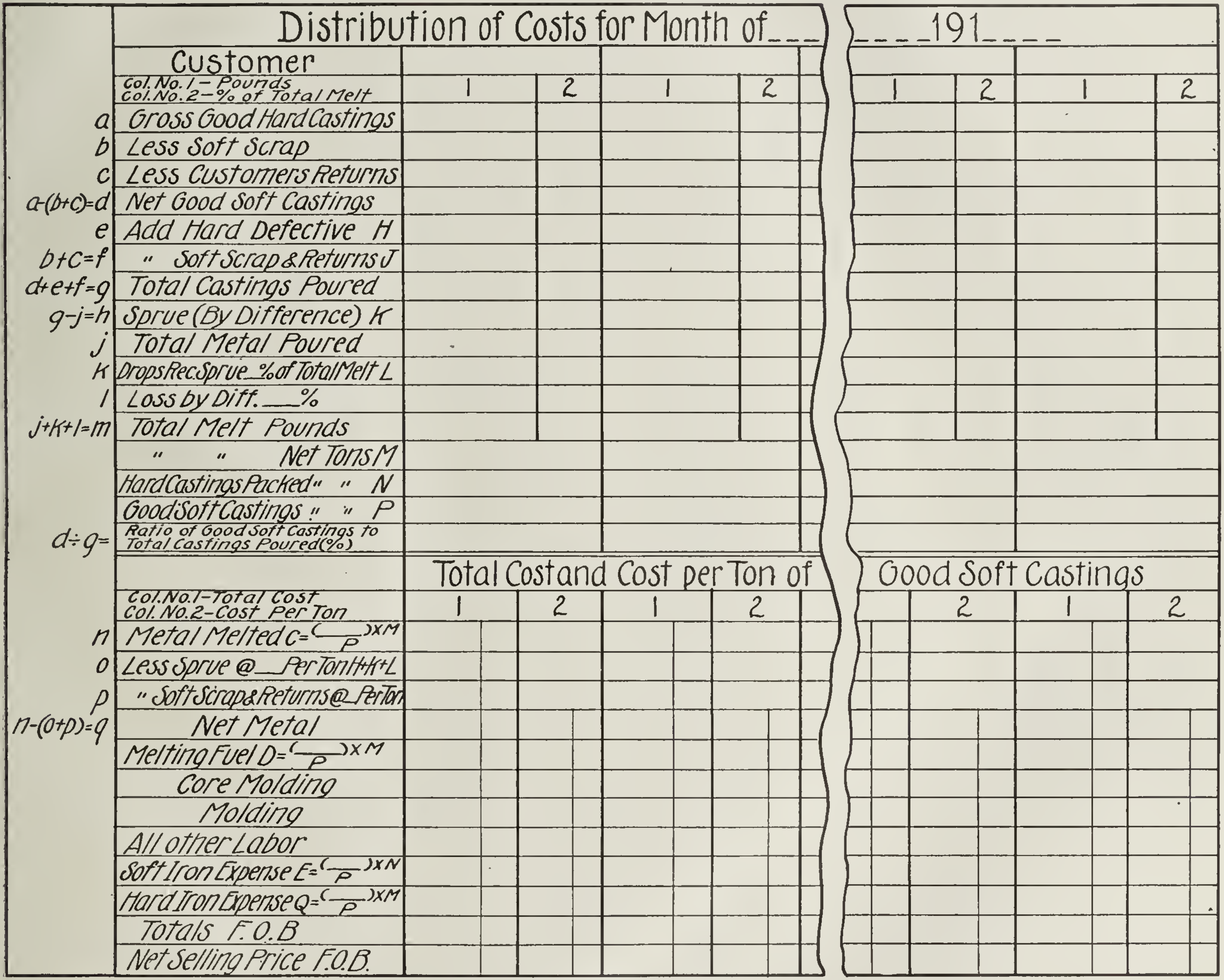
Cost Data for Month of ____ 191__ Contract ____												
Patt. No.	Total Per Mold			%C'St'G	Pounds				Metal	Total Paid For		
	Metal	C'St'G.	Sprue	B÷A	Good	Poor Broken	Soft Scrap Cus. Ret.	Total Castings	Poured	Molding	Cores	
	A	B		C	D	E	F	D+E=G	G÷C=H			

FIG. 5—FORM USED FOR GROUPING DAILY ENTRIES

These mold weights furnish a basis for determining the cost of iron in the good castings made on separate contracts, in the same manner as the corresponding figure is obtained in the average ton costs previously described.

The items of weight and cost which can be directly identified to each contract or casting, as the case may be, are entered daily in a contract cost book. A plain column-ruled book is used for this purpose and a page should be reserved for each casting. The pattern number, name of customer, mold weight, as previously mentioned, and the per cent of casting weight to mold weight, are entered at the head of each page. For each pattern the following information is entered daily from the foundry records: In the first column the total amount paid each day for molding this particular pattern; in the second column the total amount expended for making cores for this particular pattern; in the third column the number of pounds of good hard castings made each day from this pattern; in the fourth, fifth, sixth, and seventh columns are entered, respectively, the pounds of broken hard castings, pounds of defective hard castings, pounds of soft scrap, and pounds of customers returns for this particular pattern for the cost period, either by days, weeks or months, as may be most convenient. In order that there may be no delay at the end of the cost period, this book should be kept up to date. The indirect expenditures of a malleable foundry fall roughly into two general classes. In the first place is that class of expenditures which is not dependent on the amount of good castings made, but which is incurred regardless of whether the foundry realizes 8 per cent or 80 per cent of its monthly melt in good salable product.

This includes all operations up to the point where the good hard castings are separated from the remelt. Prior to this point the entire tonnage of the melt is handled either in the shape of pig and scrap before melting, or of good and poor castings, sprue, etc., after melting. This class of expense is incurred regardless of the proportion of good castings realized from the process, hence it is pro-rated over the entire tonnage of metal charged, and is distributed to individual contracts in proportion to weight. This class of expenses includes costs of unloading material, melting, general foundry labor, supervision of shop, and all general expenditures and charges of a fixed nature. For convenience it is referred to as hard iron expense.



	Distribution of Costs for Month of___					____191____			
	Customer								
	Col. No. 1 – Pounds Col. No. 2 – % of Total Melt	1	2	1	2	1	2	1	2
a	Gross Good Hard Castings								
b	Less Soft Scrap								
c	Less Customers Returns								
a-(b+c)=d	Net Good Soft Castings								
e	Add Hard Defective H								
b+c=f	" Soft Scrap & Returns J								
d+e+f=g	Total Castings Poured								
g-j=h	Sprue (By Difference) K								
j	Total Metal Poured								
k	Drops Rec. Sprue _% of Total Melt L								
l	Loss by Diff. ___%								
j+k+l=m	Total Melt Pounds								
	" " Net Tons M								
	Hard Castings Packed " " N								
	Good Soft Castings " " P								
d÷g=	Ratio of Good Soft Castings to Total Castings Poured (%)								
		Total Cost and Cost per Ton of				Good Soft Castings			
	Col. No. 1 – Total Cost Col. No. 2 – Cost Per Ton	1	2	1	2		2	1	2
n	Metal Melted C=$\left(\frac{\quad}{P}\right)\times M$								
o	Less Sprue @__Per Ton H+K+L								
p	" Soft Scrap & Returns @_Per Ton								
n-(o+p)=q	Net Metal								
	Melting Fuel D=$\left(\frac{\quad}{P}\right)\times M$								
	Core Molding								
	Molding								
	All other Labor								
	Soft Iron Expense E=$\left(\frac{\quad}{P}\right)\times N$								
	Hard Iron Expense Q=$\left(\frac{\quad}{P}\right)\times M$								
	Totals F.O.B								
	Net Selling Price F.O.B.								

FIG. 6—FORM USED FOR EXHIBITING THE FINAL COST PER TON

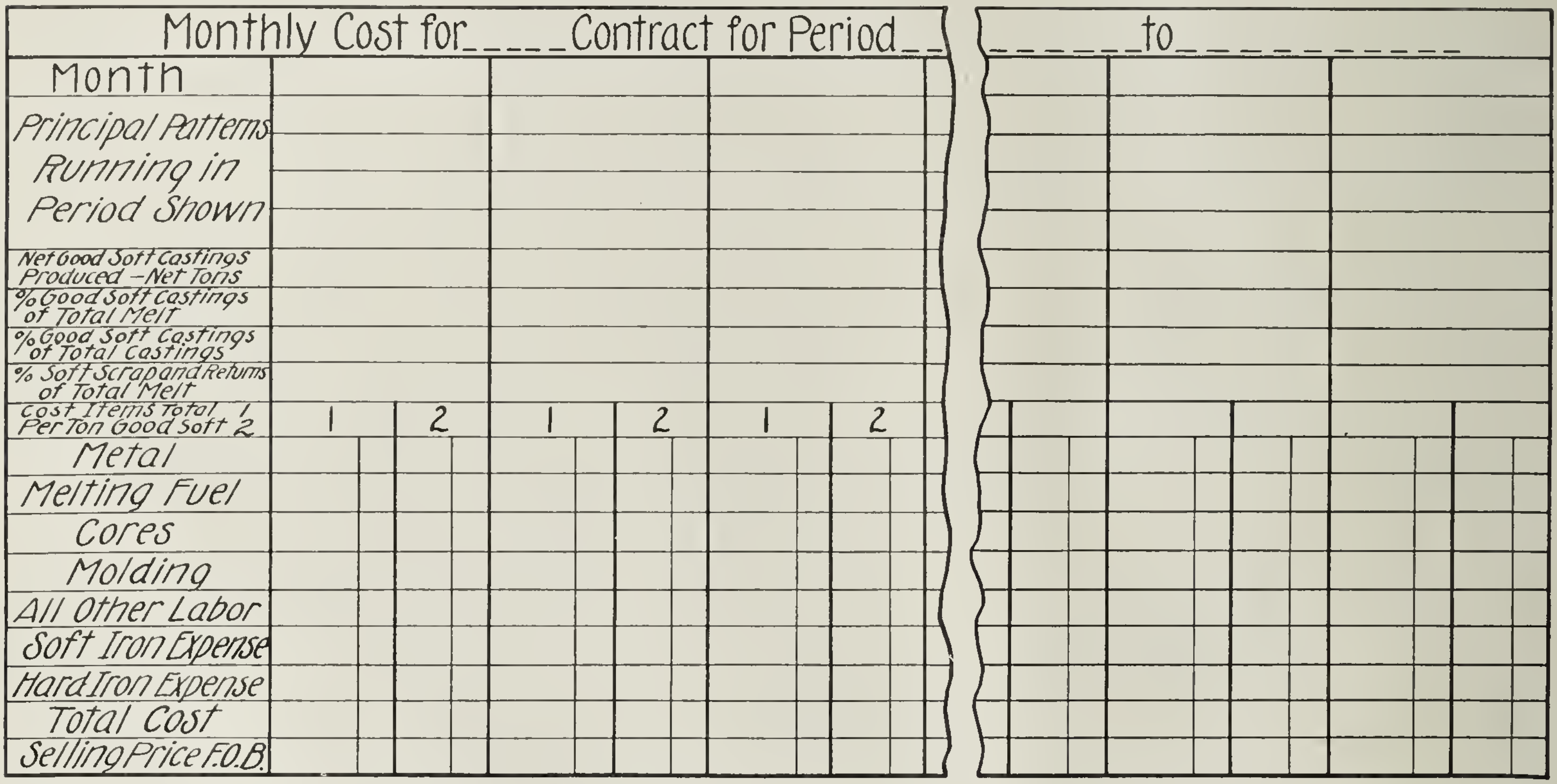
In the second place, there is the class of expenditures represented by packing, annealing, cleaning, annealing fuel, shipping, labor, etc., which are dependent on the amount of salable product realized. These are referred to as soft iron expenses. In this class, the weight of trimmed hard castings wheeled to the pot packers is used as a basis of distribution to individual contracts. The losses in annealing, and soft inspection are adjusted elsewhere in the costs. All unidentified expenditures are assigned to one or the other of these classes. From the totals of each class is determined a cost figure per ton of charge, or of good hard castings respectively. These tonnage figures, once determined for a given month, are available for all individual costs. This manner of distributing unidentified items is an approximation of the actual facts. It will be noted, however, that approximations may be eliminated, and the distribution may be extended into any amount of detail which may later be desired, without interfering in any way with the lay-out of the cost system.

The form used for the division of these two classes of expenditure is shown in Fig. 4; it also includes the calculation of the tonnage figures, at the end of the month. The weights of total metal charged, from Fig. 1, and total hard castings delivered to packers, are entered at the top of the sheet for reference. Columns are provided for the figures of the present month and the previous month in order to afford an easy comparison. The amount in dollars and cents expended each month for each item is entered in the first column, and the amount per ton of good hard castings, or of metal charged, is entered in the third column. The middle column is reserved for subtotals, as illustrated in Fig. 4. The cost of the molten iron itself, up to the time it is delivered to the furnace spout, is evidently the same for all castings. The value of the metal charged is therefore taken directly from the "cost of metal charged," as shown in the average tonnage costs, Fig. 1, and is treated exactly as though it had been melted by another concern and sold to the different floors at the time it issued from the spout. In this manner each casting assumes the cost of the metal distributed to that actual mold. The same is evidently true of melting fuel. Unidentified items are entered under the classes to which they belong, and the value per ton of their respective totals is entered in the third column. The items on the lower section of Fig. 1 are added for checking purposes only. The total gross amount should check with the figures used in the average tonnage cost, Fig. 3.

It is now necessary to group together the daily entries from the contract cost book, for all the castings on each contract. The form shown in Fig. 5 is used for this purpose. It provides for the transcription from the cost book of the totals of the items for the cost period. The castings for each contract are grouped by themselves. In the first column the pattern numbers of the castings are entered. The other column headings are self explanatory, since they are totals of the contract cost book daily entries, with the exception of columns *G* and *H* in column *G* are entered the totals of columns *D* and *E*, representing the tonnage of castings molded for the period. In column *H* is entered the weight of metal poured into molds for these castings, obtained by dividing items in column *G* by the corresponding percentage in column *C*. The weight thus obtained represents the combined weight of molds poured, including castings, gates, sprue, and runners. The totals of each sheet represent totals for the contract group for the month.

We are now in possession of the necessary data for building up the total costs of each contract for the cost period. The same method is used for building up the costs of each contract as was described in building up the average cost of total tonnage as shown in Figs. 2 and 3. Fig. 6 is used for this purpose. It is ruled in pairs of columns. Each pair is reserved for the cost of one contract. If a customer has several contract prices, a pair of columns is used for each price. In the first column are entered the total weights for the month. In the second column the per cents of the total charge are entered if desired for reference and comparison. The items are lettered at the left for the convenience of the cost clerk in making up the cost for the first time. The determination of the cost of metal used in each contract occupies the upper section of the sheet. This corresponds to Fig. 2. The same methods are followed, but the items are transposed for the convenience of the cost clerk. They are taken from the records previously described. The final cost is based on the fourth item, "net good soft castings," as this is the final weight which the customer retains and pays for. Adding to this figure the total hard and soft scrap castings, we obtain the total castings poured. To this weight a percentage is added to cover the metal lost in the melting process, together with shot, spill, etc., giving us the total metal melted (charged) for this contract for the cost period. These percentages are taken from the monthly average cost forms as shown in Fig. 2, and represent the average for the period. The line entitled "ratio of good soft castings" to total castings poured is intended to show for reference the percentage of all castings made which is obtained as good castings. In ordinary work this figure should run well over 90 per cent.

The lower section of Fig. 6 is ruled in pairs of columns in a similar manner, and exhibits the final ton cost of the contract. The total amounts expended on the contract are entered in the first column, and in the second column the cost per ton of good soft castings is entered as determined by dividing the items in the first column by the tonnage of "good soft castings" applying on the contract, as shown in the upper portion of the sheet. The value of net metal in good salable soft castings produced is evidently equivalent to the value of the total metal appropriated from the month's charge to this contract, less the value of hard and soft scrap items using the weights shown in upper part of sheet. Hard and soft scrap are priced at the fixed figures previously assumed for cost purposes. Expenditures on this contract for metal, fuel, hard iron expenses, and soft iron expenses, are obtained by the use of respective costs of these items per ton of metal charged. They are taken from Fig. 4 and multiplied by the tonnage of metal melted for this contract. Molding and core expenditures are taken directly from the total of these items shown in Fig. 5, the total of these values is the cost of salable castings made on this contract during the month. For purposes of comparison the net contract sales price, f. o. b. foundry, is entered on the last line. It will always happen that too small a tonnage has been run on some contracts during the month to



Monthly Cost for ____ Contract for Period __ ______to__________						
Month						
Principal Patterns Running in Period Shown						
Net Good Soft Castings Produced – Net Tons						
% Good Soft Castings of Total Melt						
% Good Soft Castings of Total Castings						
% Soft Scrap and Returns of Total Melt						
Cost Items Total 1 Per Ton Good Soft 2	1	2	1	2	1	2
Metal						
Melting Fuel						
Cores						
Molding						
All Other Labor						
Soft Iron Expense						
Hard Iron Expense						
Total Cost						
Selling Price F.O.B.						

FIG. 7 — FORM USED TO SHOW COMPARISON OF MONTHLY COST TOTALS DURING CONSECUTIVE MONTHS

form a basis for a cost. In these cases it is desirable to group these small jobs by themselves and the form used for this purpose is shown in Fig. 6.

Having now obtained a cost for the principal individual contracts for the given month, it is desirable to put these figures in shape for future reference. A form shown in Fig. 7, is provided for this purpose. Cards similarly headed may be used if preferred. The principal cost items for each contract are recorded on one of these sheets, each column being devoted to the figures for one month for the particular group in question. In the lower section of the sheet are entered the costs for the same period. Fig. 7, or the equivalent card index record, thus furnishes a comparison of monthly cost totals for each price group of castings during consecutive months. At the expiration of the contract, the total costs may be quickly determined by addition of monthly totals and weights.

On account of its simplicity, the weight basis of distribution of unidentified items has been followed throughout. No effort has been made to probate burden items in proportion to time or labor values, on which they may be more directly dependent; nor to obtain a weighted distribution of labor items based on the relative difficulties of production of the various patterns. Where desired these and similar refinements may be embodied in the system.

Although any written description of cost methods is bound to appear complicated, it has been found that these methods have entailed very little additional clerical labor. The work is easily handled by foundry timekeepers up to the point of assembling the total cost at the end of the month. Once the items have been grouped together for the first month's cost by the office clerk, there will be little difficulty in getting out costs for future months promptly and accurately, so that the management and the organization may use the results to the best advantage.

Bulletin No. 102, recently issued by the Stow Mfg. Co., Binghamton, N. Y., builder of portable electric tools, electric motors and special machines, has been published in miniature, having been reduced to 3¼ x 4⅞ inches. This miniature booklet will be found to be handy for quick reference.

Mixture for Bronze Parts

In the article entitled "Making Thin Wall Ornamental Brass Castings", by R. S. B. Wallace, published in the November, 1916, issue of *The Foundry*, page 476, the following statement was made: "The bronze finished parts are a composition consisting of 86 per cent copper; 1.5 per cent tin; 11 per cent lead, and 1.5 per cent zinc." The lead and zinc in this mixture have been transposed, the percentage of lead being 1.5 and the zinc, 11 per cent.

Constructing a Simple Pattern

By *M. E. Duggan*

The pattern ordered is for a connection on a high pressure pipe line. The dimensions are 10 x 10 x 10 inches, finished all over; it has a 2¼-inch T-core hole; 20 castings in steel were to be made from this pattern. Funny what foolish questions some fellows do ask. Why waste time on such simple jobs? That's what I thought when given this *simple* pattern to make. How many patternmakers think the same when asked to make some *simple* pattern?

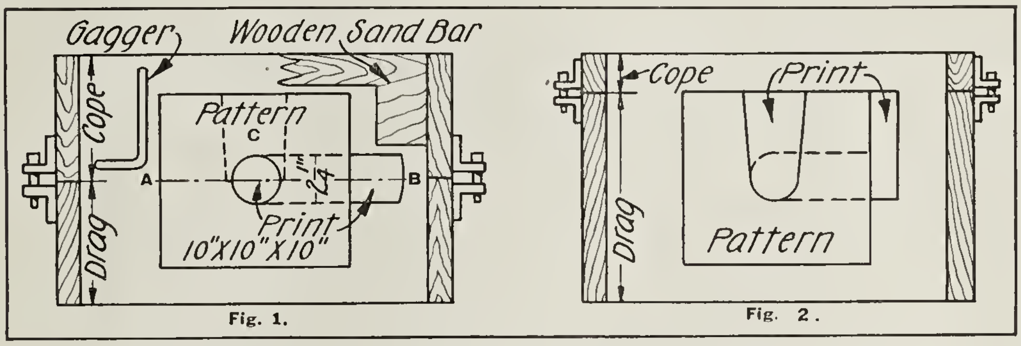


FIG. 1—THE WRONG WAY AND FIG. 2, THE RIGHT WAY OF MODDING A SIMPLE PATTERN

Seven years ago I started as a patternmaker in the place where I am now employed. During the preceding years I gave the *making* and the *molding* of these *simple* patterns very little thought or consideration; I made them in a way that I thought best; they were sent to a foundry located a mile or two perhaps 50 miles away. I never gave them a thought, never saw nor heard from them after they left the pattern shop unless a mistake was made in their construction or the molder was unable to draw them out of the mold with a crane.

The shop in which I am now employed is located only a short distance from a large general jobbing foundry, making steel, gray iron, brass and aluminum castings. I take advantage of this opportunity to visit this foundry and to watch the molder at his work and to study his art. It's a great game and one in which every patternmaker should take a hand. Each visit to the foundry serves to convince me that my knowledge of practical patternmaking and practical foundry practice is limited and that I have much to learn. There are, I dare say, a great many patternmakers in the same boat, in fact an occasional visit to the foundry and a study of their own patterns and patterns made by other patternmakers, during the process of molding will, I am quite sure, convince them, as it did me, that a *simple* pattern can be so made that it will cause a lot of unnecessary work and delay in making the mold.

The *wrong* and the *right* ways of making and molding this *simple* pattern are shown in Figs. 1 and 2. In Fig. 1 the pattern is shown as I made it, split through the center at the line *AB*, to be molded with one-half of the pattern in the cope and one-half in the drag. With one-half of the pattern in the cope a body of hanging sand would be on all four sides between the pattern and the flask, that would have to be supported and made secure in order to prevent this sand from dropping down into the mold. This is done with the aid of sand bars and gaggers. A broken section of one of the sand bars and one of the gaggers is shown in the cope half of the mold, Fig. 1. These and many other appliances, tricks of the molding trade, the patternmaker should know and understand; they are a necessary aid to the molder during the process of molding a great many *practically made patterns* and very often, he is obliged to resort to these and many other tricks of the trade when molding a pattern that is impractically made. By our ignorance of the *common things* in connection with practical molding and general foundry practice we are the cause of a lot of unnecessary labor in a great many instances.

Before describing the right way of making the pattern, Fig. 2, let us see what was done in the foundry with my split pattern. The two halves were fastened together and tail prints, shown by the dotted lines *C*, Fig. 1, were made. These changes were made in the foundry by the foreman molder. The 20 steel castings were made and delivered on time and I received no complaints from the foundry or the machine shop and had no reason to suspect that the pattern was impractical to mold or that a change had been made until I saw it when it was returned to the pattern shop

When a split pattern is returned spiked together from a foundry *there is* *something rotten in Denmark* and it's time to sit up and take notice.

The tail prints were not made out of wood and fastened to the pattern as a great many patternmakers would suppose. They were cut from a large slab core, tapered at the sides as shown by the dotted lines at *C* and rounded at the bottom end to fit down over the prints. The tools required to do this job are a common hack saw blade and an old file, and the prints are made in a very few minutes. Slab cores of various thicknesses are kept in stock in every jobbing foundry and are known by the name of stock cores.

After the change was made in the pattern it was molded as shown in Fig. 2, the whole pattern in the drag; any flask served the purpose and no special preparations or rigging were required in either the drag or the cope flask, just shovel and ram sand.

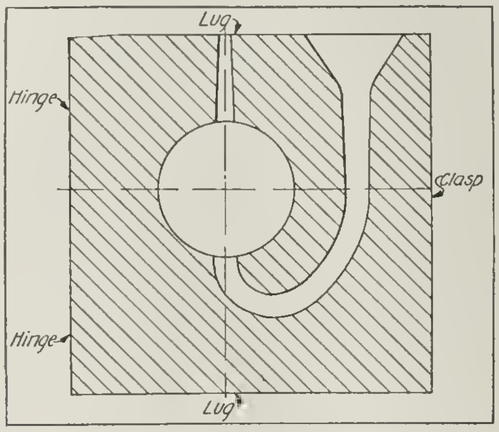
Let us see if there is enough difference in these two methods for making this very simple pattern to be deserving of the attention of the patternmaker. To make the split pattern required extra labor and time in the pattern shop. In the foundry, flasks of a suitable size for the job would have to be found and fitted with sand bars; this means a delay to the molder and he will have to *go some* to complete five molds in a day's work. With the whole pattern molded in the drag, as in Fig. 2, 17 castings were made the first day without any extra preparation or cost to the foundry. *Some difference;* simple when you know how; learn by frequently visiting a foundry. If you can't visit a casting plant have *The Foundry* sent to you. It contains lots of good and instructive reading pertaining to the patternmaking and foundry trades.

All Iron is Good Iron

By W. J. Keep.

Question:—We have received a shipment of iron containing silicon, 2.05 per cent; sulphur, 0.03 per cent; phosphorus, 0.61 per cent and manganese, 0.78 per cent. We would like to know if this is a good grade of iron, and how much scrap we can add to the iron so that it will not be too hard.

Answer:—The pig iron of the foregoing analysis undoubtedly is very good iron for certain purposes, but you do not indicate the size of the castings to be made or the purpose for which they are to be used. Heavy castings with low silicon or thin castings with high silicon will be soft. The scrap should be expected to contain 1.75 per cent silicon, 0.09 per cent sulphur, 0.70 per cent phosphorus and 0.75 per cent manganese. However, the amount of scrap which you can use will depend upon the amount of silicon in your pig iron and the higher the percentage of silicon in the iron, the more scrap it will carry. For ordinary agricultural machinery or jobbing work, the silicon in the pig you have purchased is too low, since 0.03 per cent of silicon is lost in melting and the final casting for this class of work should contain 2.25 per cent silicon. Any pig iron is good iron, but you must increase or decrease the silicon to meet your requirements. It is advisable to carry in stock a silvery iron containing 6 or more per cent of silicon with phosphorus about 1 per cent, which can be used as a softener.



SECTIONAL VIEW OF A CAST IRON CHILL FOR CASTING BALLS FOR GRINDING MILLS

The hinges and clasp should be heavy, with lugs on one-half of the chill only. After the first ball is cast the chills should be swabbed with thin clay wash.

Cast Iron Balls for Grinding Mills

By J. B. Orbison

On page 503 of the December number of *The Foundry* was published an answer to a question regarding the manufacture of balls for grinding mills. The answer by W. J. Keep seems somewhat indefinite, since it conveys no positive information relative to the production of the balls other than the *fit and try* process. I understand that these balls are used for crushing mills for reducing soft ores. The writer, some years ago, when superintendent of a plant in the central west, experienced the worry attendant upon the production of this class of material and because of this he is prompted to give briefly his experience. It was found at that time that cast iron chills were preferable, since they produced a perfect ball, which is essential for the purpose intended. However, it was only after a series of experiments that a ball free from shrink-holes was produced. In the accompanying illustration is shown a sectional view of the construction of these chills. It will be noted that the riser is inclined the reverse of the usual practice, the large end being next to the casting. For the sizes of the balls to be made by the party making the inquiry, this riser can be quite small, as its function is to serve as a vent rather than a riser. The chills were made quite heavy, hinged and clasped together and mounted on an iron stand of suitable height for pouring with a hand ladle. If the chills are carefully molded, very little machine work will be required other than drilling for the hinge pins and the clasps. If ordinary gray iron is used, the addition of 10 per cent of steel scrap undoubtedly will produce a good ball, but if charcoal iron can be had, it will be found to be preferable to leave the steel scrap out. In any event, the mixture should contain silicon, 0.50 per cent and phosphorus, 0.20 per cent.

Heat-Resisting Gray Iron

By W. J. Keep.

Question:—Kindly furnish us the analysis of gray iron castings which will resist heat satisfactorily and which are to be employed in the construction of annealing ovens.

Answer:—An analysis for iron which will resist heat satisfactorily follows: Silicon, 1.25 to 2.50 per cent; sulphur, under 0.06 per cent; phosphorus, under 0.20 per cent; manganese, 0.60 to 1 per cent and carbon, low. The foregoing analysis was submitted at one of the meetings of the American Foundrymen's Association and I believe was obtained from a number of manufacturers who specialized in heat-resisting castings. However, I know of no conclusive experiments which have been made to determine the best mixtures for this purpose. I have asked many chemists for information on this subject, but invariably they have asked me to forward a casting which has proved desirable for this class of work, from which they could make an analysis. It would be exceedingly difficult to use scrap and obtain the foregoing analysis, and it hardly would be expected that the introduction of steel scrap would produce this result and still would give a desirable casting. I think that sulphur, 0.08 per cent and phosphorus, 0.50 per cent, would be as low as could be employed economically, and I think silicon should be much higher than the percentage given, close to 3 per cent preferably. Usually the strongest castings with the closest grain are those which contain silicon as low as will still permit of machining, and the other elements should be as low as those given by this analysis. You can avoid shrink-holes and open grain and still have the casting soft by using 10 per cent of clean cast iron borings, packed 100 pounds in wooden boxes, which should be charged as so much pig.

How to Use Titanium in Making Steel Castings

Some of the Many Metallurgical Difficulties of the Steel Foundry Are Discussed and Remedies Are Named for Their Elimination

By W. A Janssen

NOTWITHSTANDING all that has been said concerning the harmful effects of phosphorus and sulphur in steel, the occluded oxides and gases, such as iron oxide, Fe_2O_3, and an undefinable oxide, probably FeO, free oxygen, nitrogen, and occluded slags, are the real causes of many of the troubles of the steelmaker. It is with the occurrence of these elements and their elimination that he is especially concerned. It has been definitely demonstrated that the presence of oxygen, and possibly nitrogen, in steel reduces its static strength, dynamic properties and abrasive values and increases its tendency to corrode. Today the presence of oxygen and oxides in steel is considered more harmful than even relatively large amounts of phosphorus and sulphur. In a measure the same is true of nitrogen, although the investigations in this direction have not been sufficiently complete and the results are variable and uncertain. Advanced methods of analysis show the isolation and determination of both of these gaseous constituents. Unfortunately insufficient credence has been given to their existence. Many analyses of steel will disclose an oxygen content of approximately 0.05 per cent. This may be compared with the analysis of other undesirable constituents, such as phosphorus and sulphur. It must, however, be borne in mind that it is not the nascent oxygen itself which causes the harm, but rather the compounds which it so readily forms. The presence of 0.05 per cent oxygen may mean, if it is combined with the iron, the existence of 0.22 per cent of oxide of iron, an amount sufficient to materially affect the quality of the metal. Bessemer or converter steels contain the largest amount of occluded oxides, with the open-hearth steels next (the steel made by the basic process contains more than that made by the acid process), crucible steels next, and electric steels last. The steels made in the electric furnaces are practically free from oxides. It will be seen that the accepted range of the quality of steels, from the oxidizing bessemer process to that of the electric furnace, is determined by the freedom from occluded oxides.

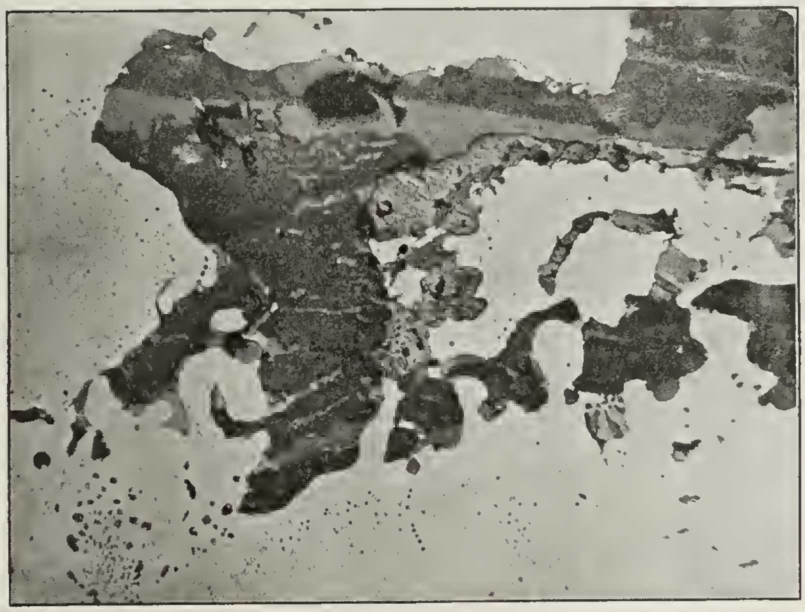


FIG. 1—COMPLEX SLAG INCLUSIONS CONTAINING OXIDES, SULPHIDES AND SILICATES
(Magnified 200 Diameters)

It is an established fact that the presence of oxides in steel materially accelerates corrosion. All impurities in steel are electro-negative as compared with iron except the oxide of iron which is electro-positive. The difference in potential set up between this couple in the presence of moisture or dilute acids causes the steel in the proximity of the oxide areas to corrode rapidly and thereby accelerating deterioration. The reason for the occurrence of cracks in steel castings is an oft debated question. Aside from cases where no consideration has been given to the proper distribution of metal in the design of the casting, unduly restricting the cooling and shrinkage, the cause for cracks has been considered to be due to red-shortness. These defects usually are found where the metal, in cooling from its liquid through its plastic or viscous state, due to its lack of stability, cracks under pressure of restricted shrinkage. Sulphur, to which is usually attributed the cause for red-shortness, is generally given credit as being the cause of the cracks. Even when the casting has been designed properly and made with a sulphur content of not over 0.025 per cent, these same cracks appear periodically. An examination of these cracks, even with this abnormally low sulphur content, discloses a crystalline fracture. It has been observed that when the furnace is again brought to a normal condition of operation and the amount of occluded oxides reduced, these cracks again disappear. It is known that this occluded oxide of iron also has the property of causing red-shortness. Furthermore it has been observed that in an over-oxidized metal, in the range of the plastic state of cooling, the liability of the occurrence of cracks is greatly increased. That these cracks occur in castings which are uniformly sound and free from blow-holes throughout, seems to indicate that the normal additions of the deoxidizers, ferro-silicon and ferro-manganese, which are governed by specifications, do not entirely free the metal of its oxides. The introduction of these oxides into the metal is primarily dependent upon furnace manipulation. In the bessemer process it may de due to over-blowing, in the open-hearth process to the use of too sharp a flame, the admission of too much air for combustion or the use of too much ore in refining. Even in the electric furnace, which is supposed to refine steel in a neutral atmosphere, oxides find their way into the metal due to the inability to maintain a calcium-carbide slag, which is the primary function of an electric furnace in the production of deoxidized steel. With present-day furnace operation, which at best is variable and manipulated by rule-of-thumb, the steelmaker must have at his command a positive deoxidizer or cleanser to augment the ordinary deoxidizers such as ferro-silicon and ferro-manganese.

With the advent of ferro-alloys of silicon and manganese containing high percentages of the active elements came the hope of an assured uniform quality of steel. As deoxidizers, modern ferro-alloys are efficient in a measure, but have certain limitations. It is the

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A paper presented at the Cleveland meeting of the American Foundrymen's Association.

function of these deoxidizers to combine with the occluded oxides; the resulting products rise and become a part of the slag. Unfortunately, the temperature of the metal and its resultant fluidity do not always permit these deoxidizers to complete their cycle and rise to the slag; they are entrapped as inclusions and the occluded gases are not entirely deoxidized. The known presence of oxides in excess of the amount which can be deoxidized by the usual additions of ferro-silicon and ferro-manganese is not permitted because of specification tolerances for manganese and silicon content.

Silicon, comparatively speaking, is not a strong deoxidizer, and when it is added to steel a portion of it remains in the steel either as an alloyed constituent, or the products of its oxidation may remain as inclusions. The usual analyses for silicon do not disclose whether or not the silicon is present in the steel as an alloyed silicide, as silica or as the silicate. Even if the silicon manifests itself as a silicide, showing a high silicide percentage, a wild heat is apt to result, requiring the use of a further deoxidizer (aluminum) when pouring the molds. In conjunction with manganese, double silicates of iron and manganese frequently are formed. Such a constituent may contribute to excessive segregation, although singularly, a dirty steel often discloses very little segregation.

The oxide of manganese formed with the use of ferro-manganese as a deoxidizer, although of low specific gravity may not rise and become a part of the slag; instead it becomes entrapped and reacts with the carbon of the steel to form carbon monoxide. The chemical formula is as follows:

$$MnO + C = Mn + CO$$

Chemical analyses do not disclose in what combination manganese is present in the steel, whether as a sulphide, carbide or oxide. If present as a sulphide or carbide, it may manifest itself as a segregated area of weakness. If present as the oxide of manganese, it exists in its most deleterious form. The existence of oblong surface blow-holes may be said to be due directly to the presence of manganese oxide, indicating the fact that the metal has not been thoroughly deoxidized. As previously stated, the manganese-oxide reacts with the carbon of the steel to form carbon monoxide, which, by expansion, will be forced to the surface of the casting, resulting in the formation of oblong blow-holes. This same type of blow-hole may exist due to the reaction of the carbon of the steel with the iron oxide. Blow-holes may also exist in other parts of the casting. Usually they are either spherical or lenticular in shape and generally they are due to imperfect molding, imperfect venting, damp sand, or the entrapping of air or aqueous vapor formed by the hot steel.

The actual effect of nitrogen in steel is still a mooted question. It is only comparatively recently that any research has been done on this subject, the most of which has been performed by European metallurgists. In a measure their findings have been incomplete and their results somewhat variable. This may be due to a variance in the methods of analysis. Some investigators, even after synthetic incorporation of nitrogen, on analysis find less nitrogen present than others find in the usual product of the furnaces. By some it is held that the effect of nitrogen in steel is much the same as phosphorus, in that it causes cold-shortness and brittleness. Analysis of steel for nitrogen seems to indicate that the greatest amount is found in bessemer steel, with smaller amounts in the open-hearth product and still less in steel made in crucibles and electric furnaces. The amount present in the latter processes is dependent on the nitrogen content in the stock charged. If the presence of nitrogen be determined and if it is considered undesirable, its elimination or reduction can only be effected by titanium to form stable titanium-nitride, ferro-silicon, ferro-manganese and even vanadium having no affinity for nitrogen.

To augment the deoxidizing effect of ferro-silicon and ferro-manganese, steel-makers have resorted to the extensive use of aluminum. Aluminum is the most powerful deoxidizer known. Nevertheless its use in quantity is a menace in that the resultant product of oxidation—alumina—is a viscious oxide which has a melting point at 2,010 degrees Cent. This material is infusible at the temperature of the molten steel and also renders other slags infusible. Because of its physical characteristics, the alumina, as formed frequently, does not find its way to the slag, but remains entrapped in the steel as shot or streak inclusions.

Titanium, until a comparatively few years ago looked upon as one of the rare metals, undoubtedly is one of the most powerful deoxidizers and denitrogenizers known. Titanium as an element is a hard, brittle material having a grayish, silver luster. It has a melting point of about 2,300 degrees

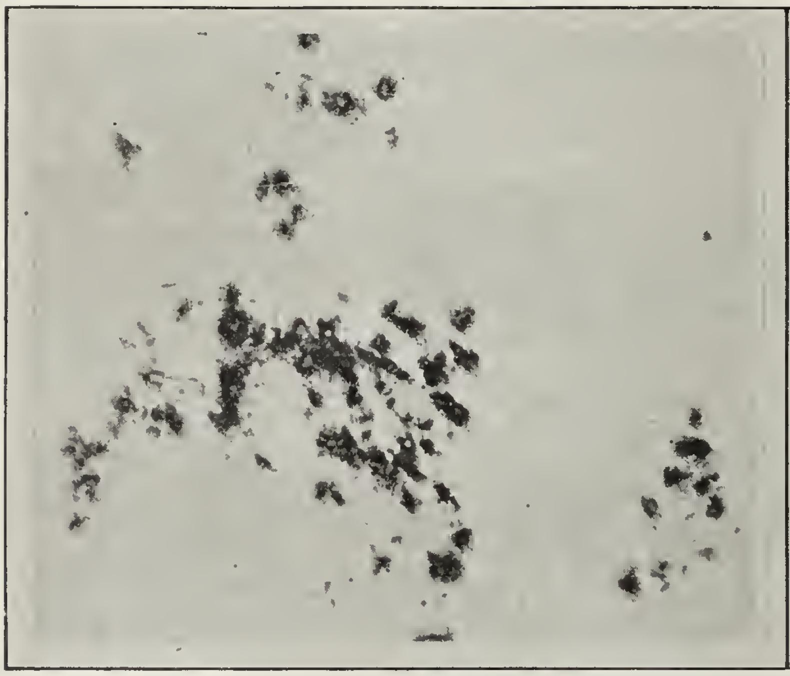


FIG. 2—MICROPHOTOGRAPH SHOWING A GROUP OF ALUMINA PARTICLES IN PLAIN STEEL
(Magnified 400 Diameters)

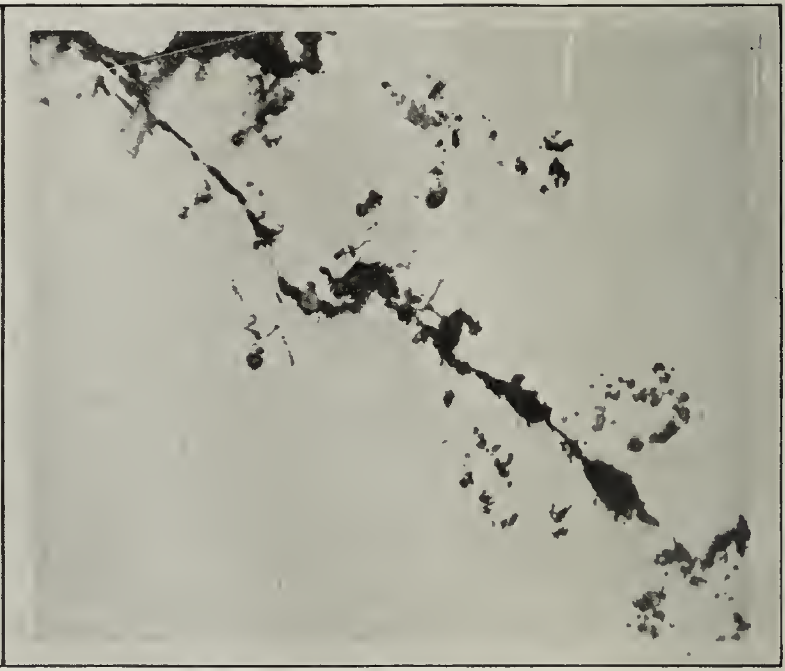


FIG. 3—CRACKS EXTENDING THROUGH SMALL GROUPS OF ALUMINA INCLUSIONS IN TITANIUM-TREATED STEEL TO WHICH ALUMINUM ALSO WAS ADDED
(Magnified 200 Diameters)

Cent. Titanium burns energetically in oxygen and is the only known element which "burns" in nitrogen. It is widely distributed in nature, usually as a dioxide in rutile, brookite, anatase and in some clays and as ferrous-titanate in titaniferous iron ores. The knowledge of its effects has long been classic. The use of titanium, however, was prohibitive because of its high cost. Titanium at the present time may be obtained as one of the ferro-alloys.

Ferro-Alloys of Titanium

The ferro-alloys of titanium, in general, are produced by two distinct processes, by the electric furnace process as developed by Auguste F. Rossi, and by Dr. Hans Goldschmidt by his well-known aluminothermic process. Each of these alloys have their particular application, the function of both, however, being the same. The ferro-alloy, made by the Rossi process, consists essentially of microscopic particles of titanium-carbide held in a matrix of gray iron. Its analysis is as follows: Titanium, 15.79 per cent; carbon, 7.46 per cent; silicon, 1.41 per cent; manganese, 0.11 per cent; phosphorus, 0.05 per cent; sulphur, 0.08 per cent; iron, by difference, 74.30 per cent. The analysis of the alloy made by the Goldschmidt-thermit process is as follows: Titanium, 0.22 per cent; manganese, 0.50 per cent; carbon, less than 0.10 per cent; aluminum, 5 to 8 per cent; phosphorus, 0.10 per cent; silicon, 0.75 per cent; sulphur, 0.02 per cent; iron, by difference, 70.31 to 73.31 per cent. The product made by the thermit process, it will be noted, is peculiar because of its aluminum content and freedom from carbon.

The chief value and merit of titanium lies in its positive action in the removal of the occluded oxides, nitrogen and entrapped slags, due to the fusibility of titanic oxide as formed and its greater stability as compared with iron oxide. Its function is further augmented by the increased fluidity due to the increased temperature because of the exothermic reaction, thereby permitting freer movements of the oxidized products to slag.

The present-day method of using ferro-titanium is to augment the incompleted cycle with ferro-titanium after the other deoxidizers have been added. These may be added in the ladle, or in the furnace before tapping. After the titanium has been added, it is imperative and essential that the ladle be held from five to 10 minutes before pouring in order to allow time for the completion of the reactions. No fear need be had of the chilling of the metal inasmuch as the temperature is raised appreciably, due to the exothermic reaction. It is essential that the titanium be not added until after the additions of ferro-silicon and ferro-manganese have been made. On account of the greater affinity of titanium for oxygen, the ferro-silicon and ferro-manganese must be given an opportunity to complete their primary deoxidation, thereby eliminating selective oxidation. It is also essential that the ferro-titanium be added as soon thereafter as possible so that the alloy does not become a part of the slag and there perform its deoxidation. Ferro-titanium has its application as a deoxidizer and cleanser in the crucible, converter, open-hearth and electric furnace processes of steel manufacture, as well as in the cast iron and malleable iron industries. If ferro-titanium be used in the crucible process, it may be added as a part of the charge, being placed well down toward the bottom of the pot, or added after the manganese addition has been made. Because of its intensified affinity for occluded gases and cleansing action on inclusions, its use extends to the metallurgical processes for the more common non-ferrous alloys and also to the rare metals.

Titanium in combining with oxygen to form titanium-oxide, with a heat of formation of 215,000 calories, acts as a flux for silicates and other slags, which normally would remain in the slag, rendering them sufficiently fluid to rise through the metal and pass into the slag. Titanium at about 800 degrees Cent., combines with nitrogen to form the stable titanium-nitride which usually finds its way to the slag. Microscopic examination, however, sometimes reveals the existence of occluded tiny, hard, pink crystals of titanium-nitride which, however, are less harmful in effect than the occluded nitrogen. With all these beneficent effects, its use beyond a certain amount is of no avail and in a measure harmful.

Does Not Alloy with Steel

Titanium, singularly, does not form alloy steels as do the other deoxidizers such as silicon, manganese and vanadium. Many analyses of titanium-treated steels do not reveal a titanium content higher than 0.025 per cent. With the use of alloys containing more than 10 to 15 per cent titanium, the results are not as effective, owing to the slower rate of solution. Much has been said and written about the relative efficiencies of ferro-carbon-titanium and the carbon-free alloys, with particular reference to their com-

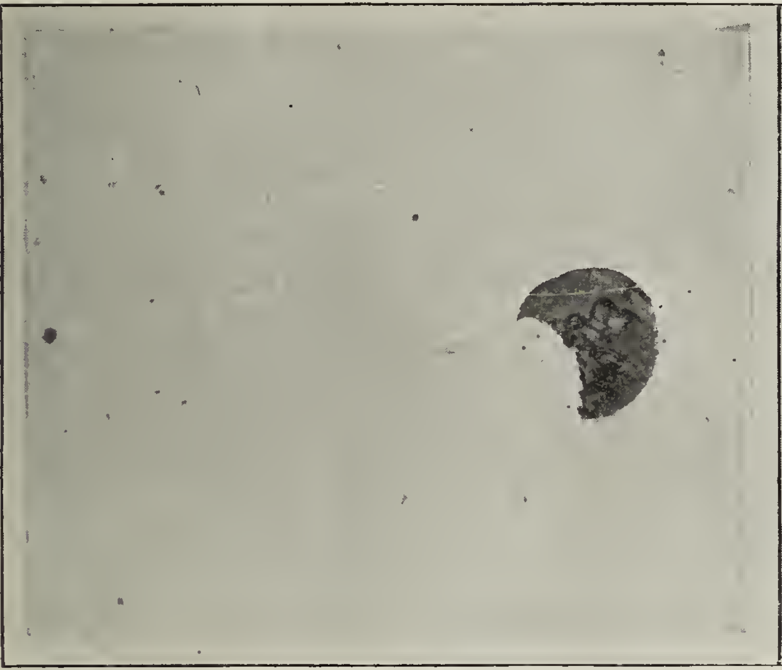


FIG. 4—TYPICAL SILICATE OR SLAG INCLUSIONS IN PLAIN STEEL
(Magnified 200 Diameters)

FIG. 5—STREAK OF FULL PARTICLES OF OXIDES IN PLAIN STEEL
(Magnified 200 Diameters)

parative solubilities because of the carbide content. The carbon in the ferro-carbon-alloy in excess of that present as titanium-carbide is present almost entirely as graphitic carbon, which in all probability does not affect the rate of solution. If there be an effect, in all probability it is offset by the lower rate of solution of the alloy of higher titanium content. The carbon free alloy has a special application to the lower carbon steels of definite carbon content which might be increased by the use of the carbon alloy. Its use, however, involves the presence of aluminum with possible Al_2O_3 contamination.

The amount of ferro-titanium used depends in a measure on the kind of steel to be treated. In rail steel, an addition of 13 pounds of the 15 per cent alloy per net ton, representing a metallic titanium addition of 0.10 per cent is satisfactory. In the use of titanium for steel castings the addition of 1½ to 2 pounds per ton of metal charged, in addition to the usual ferro-silicon and ferro-manganese additions is usually sufficient to deoxidize the steel. The amount of ferro-titanium added, however, should be dependent on the quantity of impurities which are to be removed and the process of manufacture.

Eliminating Sulphur and Phosphorus

Some claims have been made for the use of titanium in excess of the amounts necessary for deoxidation in the elimination of sulphur and phosphorus, or at least to convert them into compounds having less harmful effects. It has been stated that the sulphur is eliminated as a sulphide or as a sulphocyanide of titanium and that the phosphorus passes to the slag as titanium-phosphate. These claims in their entirety, however, have not been substantiated.

Blow-Holes in Soft Steel

In the low carbon or soft steels the presence of blow-holes, occluded gases and slag inclusions is greatly aggravated due to the metal being longer subjected to the oxidizing action of the flame or blast or because of its being necessary to increase the temperature of the metal for successful and economic teeming. Soft steels, because of this low carbon content, cool more rapidly after having reached a point of initial solidification, thereby the occluded gases are not afforded sufficient time to escape before the metal has reached its plastic state. Titanium, properly apportioned in conjunction with proper treatment, will cleanse and purify the metal. With the use of titanium in the higher carbon steels, it has been found that these steels are softer and less brittle than steels of the same carbon in which titanium has not been employed due in all probability to the more uniform distribution of the ferrite network.

In alloy steels, where special alloys such as nickel, chromium and manganese are added because of a special function, the quality and properties of the metal are improved by the further addition of titanium for the elimination of the oxides of nickel and chromium, both of which contribute to the brittleness of steel. The manufacture of manganese steel is greatly benefited by the proper addition of titanium. With the use of this alloy, the manganese is disseminated uniformly, resulting, with proper heat, in a tough, homogeneous product.

During the past few years specifications for steel castings for specific designs and service have demanded the use of vanadium. Although the presence of vanadium in steel undoubtedly has improved its physical properties, it is questionable whether vanadium manifests its maximum efficiency in plain carbon steels, especially within the carbon range of steel castings. The vanadium addition is calculated as an alloying constituent, the amount present in the final product being within three or four points of the desired calculated content. Vanadium has manifested its greatest value when used in conjunction with chromium and nickel as a deoxidizer. Vanadium is only 70 per cent as efficient as titanium and has but little effect on nitrogen.

Improves Quality of Steel

It will be seen that with proper proportioning of the alloy and proper manipulation of the heat, steel is improved in density, strength, toughness and durability, when titanium is used. This improved quality of product is not due to any direct or alloying effect of titanium, but rather to its value as a deoxidizer and cleanser in removing harmful occluded gases and slags. It must not, however, be looked upon as a cure-all to rectify the evils of poor stock selection and bad furnace practice, but rather to make good steel better by further augmenting the incomplete reactions of the best present-day deoxidizers and clarifiers.

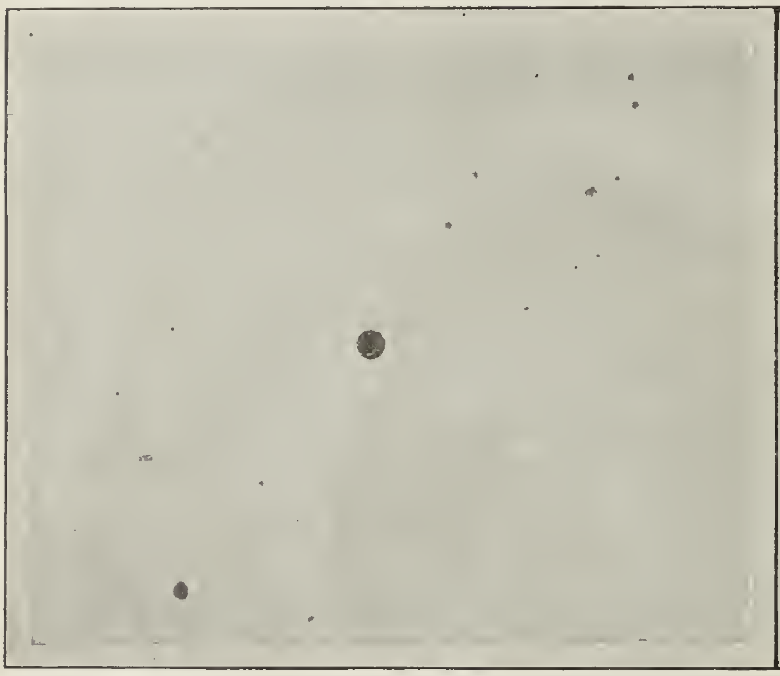


FIG. 6—TYPICAL SMALL SILICATE OR SLAG INCLUSIONS IN TITANIUM-TREATED STEEL
(Magnified 200 Diameters)

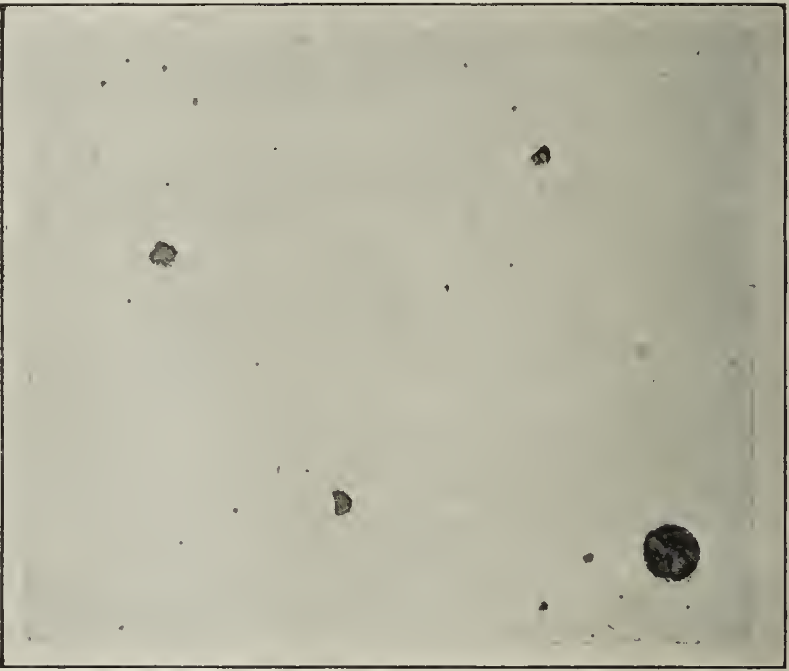


FIG. 7—INCLUSIONS OF ALUMINA, SILICATES AND SULPHIDES IN PLAIN BESSEMER STEEL
(Magnified 200 Diameters)

With the elimination of the occluded oxides and slags, steel, because of its increased density and homogenity, has improved static and dynamic properties. A comparative test of 20 untreated and treated heats showed an increase in the ultimate strength of approximately 15 per cent with no reduction in elasticity and contraction. A remarkable endurance test was conducted by Enrique Touceda on untreated and titanium-treated steels of practically the same chemical composition. The test was conducted on a Wright-Souther machine at a fibre stress of 38,872 pounds. The untreated steel withstood 2,676,000 revolutions at this pressure, whereas the titanium-treated steel withstood 18,274,900 revolutions at pressures varying from 38,872 up to 45,939 pounds fibre stress. A large number of tests made in rails and machine parts indicate the ability of titanium-treated rails to withstand shocks and abrasion, the life of gears and rails being about 50 per cent greater than those made of untreated steels. In a comparative test on gears it was found that titanium-treated gears, although made of 0.20 per cent carbon steel, too soft to be ordinarily considered acceptable for machine parts, outlasted untreated steel gears of the same composition three to one.

FIG. 8—TYPICAL SMALL GROUPS OF SILICATES AND SULPHIDES IN TITANIUM-TREATED STEEL
(Magnified 200 Diameters)

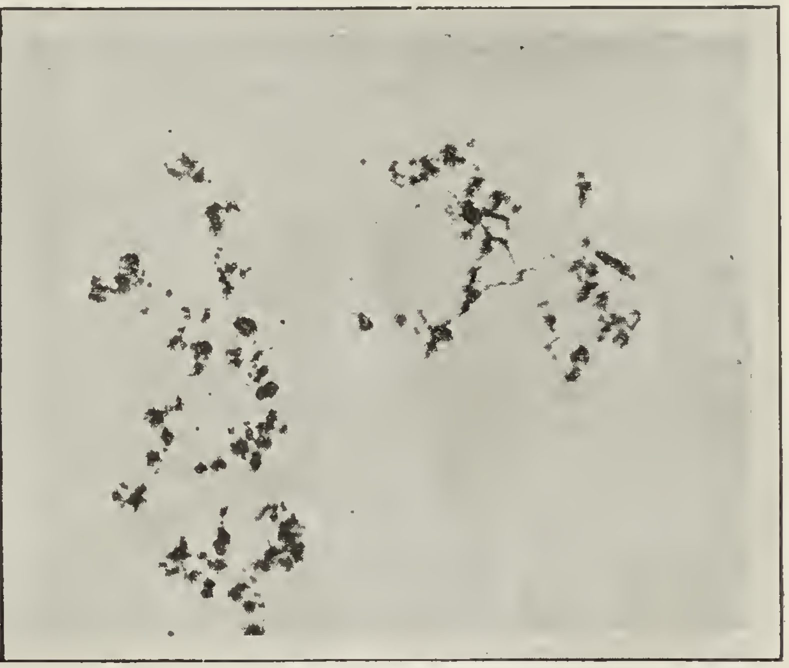


FIG. 9—A GROUP OF ALUMINA PARTICLES IN PLAIN STEEL
(Magnified 200 Diameters)

Steel, instead of being a homogeneous chemical compound, must be considered as a hetereogeneous mechanical aggregate of crystals of definite shapes, welded onto the adjacent crystals. The efficacy of these welds and the ultimate strength of steel against fracture, rupture and fatigue is directly dependent upon the absence of segregated impurities which segregate at the boundaries of these crystals. With the elimination of these occluded impurities by the use of titanium these crystals are brought into a closer weld with one another. Segregation is further reduced by the elimination of the occluded oxides, which, because of lower specific gravity, rise and form a path for the selective segregation of phosphorus, sulphur and the crystals of higher carbon constituency.

Experiments Made

With the present high cost of ferro-manganese and the attendant shortage of supply, the writer has carried on some extensive experiments to conserve his ferro-manganese without affecting the quality of the product. Realizing that the manganese present in steel castings contributes only indirectly in increasing the strength, the purpose of these experiments was to reduce the manganese from 0.75 to 0.50 per cent. To be assured of the same strength, the usual ferro-manganese addition was reduced from 320 pounds for a 20-ton heat to 200 pounds and the ferro-titanium addition increased from 60 to 120 pounds. Tensile tests for these heats showed an average ultimate strength of 68,000 pounds, for a 0.20 per cent carbon steel, with an average elongation of 30 per cent and a reduction of area of 47 per cent.

It can be well appreciated that the use of ferro-titanium in making steel castings is no longer an innovation, but rather a necessity to offset the vagaries and shortcomings of present-day practice, thereby making good steel better.

Shrinkage of Malleable Cast Iron

By Richard Moldenke

Question:—We are manufacturers of motor trucks and are having considerable trouble with certain malleable castings which we purchase in large quantities. One of our principle difficulties is with spring hangers, which measure from 45 to 50 inches in length. These castings come to us from $\frac{3}{16}$ to $\frac{3}{4}$-inch short and we are told that this is due to the castings buckling while standing on end during the annealing process. Will you kindly advise us if this is a fault which can be avoided by better annealing practice? If the trouble cannot be eliminated, we shall be obliged to substitute some other metal for malleable iron for this part. Also, we find that a number of our castings are warped at points where they should line up for drill press work. Is this not due to careless handling or poor annealing?

Answer:—There is little excuse for the shortening of malleable casting through buckling while in the anneal. Malleable foundries doing railroad work are familiar with this situation and are particularly careful in packing their long brake-beam castings so that they will neither warp nor buckle. Gross carelessness must be accountable for the shortening of your castings from $\frac{3}{16}$ to $\frac{3}{4}$ inch in 4 feet, due allowance for contraction having surely been made in the pattern.

Some malleable makers use large amounts of steel scrap in their mixtures, as an easy way to get strength, ductility and softness without holding their silicon very low. In other words, instead of paying the closest kind of attention to their melting practice so that good results are obtained with low silicon heats, these foundrymen cut their total carbon down very low by the steel additions, get into all kinds of trouble with their anneal, and eventually have to resort to the European high-temperature method to save their work. One of the bad results is the very great variation in contraction both in the hard casting and in the subsequent anneal.

Taking the case in point, with not over 5 per cent steel in the mixture, the contraction of the hard casting may vary from 3/16 to 5/16-inch to the foot during the same heat. Half of this contraction is supposed to be recovered in the anneal, making the net contraction (erroneously called shrinkage) 3/32 to 5/32-inch to the foot, or roughly 1/8-inch. In 4 feet, the original contraction would have been 3/4 to 1 1/4 inches; the pattern may provide 1/2-inch on the supposition that the end contraction after anneal would be that amount, whereas it would really run from 3/8 to 5/8-inch with the best of heats. Now, with high steel mixtures, long heats and poor melting practice, not only will the variation in contraction be greater, but the expansion in the anneal will not be as regular as it should, and therefore the castings will be anything but true to pattern.

In the recently revised standard specifications for malleable castings, the allowable variation of castings from the pattern has been increased from 1/16-inch to 3/32-inch per foot. In the case in point, a reduction in length of 3/8-inch would be allowable under the present specifications.

Warping at points that should line up for drill press work can be corrected. If the foundry in question is informed of the particular requirements of the case, the castings can readily be straightened out before shipment. There should be no necessity for turning to other materials than malleable castings for these long spring hangers. There are plenty of malleable foundries that are perfectly able to handle the situation.

Casting Iron Around a Rigid Center

By W. J. Keep.

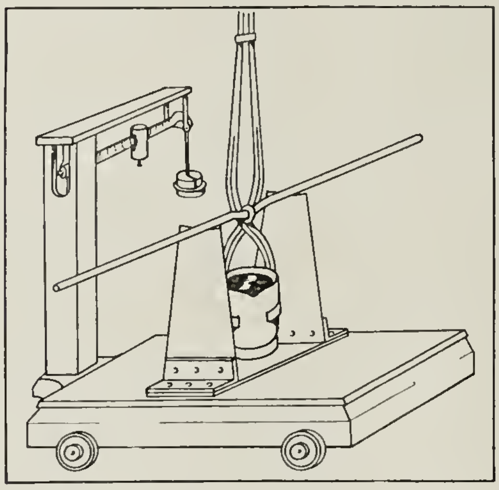
Question:—We are manufacturing furnace doors, inside of which fire brick must be cast, but all of the cast parts of the doors have cracked. We tried gating the castings in different ways and we have left a row of brick in the center to give the frame an opportunity to contract. Also, the brick have separated 1/16 inch and the interstices were filled with loose sand. Kindly advise us how these doors can be cast without cracking.

Answer:—It is impossible, of course, to prevent iron from contracting as it cools. However, it is possible to reduce this contraction by increasing the silicon to approximately 3 per cent, but even at that, it is necessary to arrange the bricks in such a way as to enable the iron to contract to some extent. A few layers of thin asbestos paper laid against the edges of the brick or a porous clay wash will compress sufficiently to prevent cracking. Many years ago I tried to make such castings and visited a foundry in Pittsburgh where a patented fire back was made by casting iron around fire brick, and I am inclined to believe that either asbestos or a porous clay wash was used to provide for the contraction of the iron and to prevent the castings from cracking.

A Time-Saving Stand for Checking Melting Losses in a Brass Foundry

By E. Tonkin

In checking the melting losses of a brass melting furnace, considerable trouble is experienced and time is lost in weighing the molten metal in crucibles on account of removing the carrying bar or balancing it on the tongs holding the crucible before weighing the hot metal in the pot.



STAND FOR WEIGHING MOLTEN BRASS IN CRUCIBLES

The accompanying illustration shows how this difficulty is overcome by building a stand with plates for the sides made of 3/16-inch steel, 7 inches wide at the top with a V-notch 1/2 inch deep, 12 inches wide at the bottom and 18 inches high. These are riveted to a 3/16 x 12 x 24-inch steel plate with 3/8 x 3 x 3 x 12-inch angles. The rivets in the bottom of the plate are countersunk, to allow the stand to rest evenly on the scales.

Safety First was considered when the V-notches were provided in the top and all steel construction was decided upon to prevent fire from the heat radiated by crucible.

The carrying bar when resting on the stand in the scales, is just the carrying height of the average man; therefore it requires little effort by the carriers to place this crucible on the scales or to take it off. The stand is light and can be removed easily to weigh the charge.

An example of weighing the charge and the hot metal from a furnace of 700 pounds capacity, follows:

	Wght. of chge. pounds.
Turnings	325
Copper	95
Defective castings	200
Zinc	15
Lead	10
Total	645

Hot metal as poured from the furnaces:

Crucible.	Weight of crucible, tongs, bar and stand, pounds.	Weight of hot brass, crucible, tongs, bar and stand, pounds.
First	150.0	312.0
Second	153.0	309.5
Third	154.0	310.0
Fourth	156.5	311.5
Total	613.5	1,243.0

Wght. of hot metal 1,243.0 — 613.5 = 629.5 lbs.
Loss 645.0 — 629.5 = 15.5 lbs.
Melting loss 2.40 per cent

Pond Truss for Buildings

Steel sashes, rolled steel skylights and other apparatus to supply proper ventilation, and to admit sufficient light to industrial buildings are treated in a 100-page catalog issued by the David Lupton's Sons Co., Philadelphia. The booklet contains reproductions of photographs of buildings built for the Ford Motor Co., B. F. Goodrich Co., Remington Arms-Union Metallic Cartridge Co., Mercer Automobile Co., Erie Malleable Iron Co., John A. Roebling's Sons Co. and others.

The Lupton company has perfected a type of roof known as the Pond truss, particularly adapted to buildings where large volumes of hot air and gas are produced, such as foundries and forge shops. The roof surfaces slope upward to wide outlets, the series of sash being hung in the outer walls of the monitor. The width of the inverted portion of the roof depends on the particular requirements of the installation, but is usually about one-half the building width. The rapid flow of air is continuous as long as heat is developed in the building. In a foundry the cold air enters through the side wall openings, and, falling to the floor, flows between the walls until it becomes heated, when it rises and follows the roof slopes to the open monitor sash. It is claimed that there is a total absence of heat pockets, return currents and down drafts. The gas fumes leave the truss on the side exposed directly to a strong wind as well as on the leeward side, providing the sloping lines of sash on the windward side are closed or partly closed, the vertical lines remaining entirely open.

Aluminum-Bronze Tests and Their Significance

Various Physical Properties Are Given and Micro-Photographs of Various Specimens Are Included—Results of Heat-Treatment

By W M Corse and G F Comstock

IN THE course of our work in making non-ferrous metal castings to exact specifications, numerous tension tests on 10 per cent aluminum-bronze were made by the authors, mostly on small cast-to-size bars made in green-sand molds. Average results of these tests gave close to the following figures:

Proportional limit, lbs. per sq. in...	19,800
Yield point, lbs. per sq. in..........	24,000
Tensile strength, lbs. per sq. in....	77,000
Elongation in 2 in., per cent.......	24.5
Reduction of area, per cent........	25.2

The proportional limit was determined with the autographic device provided on the Olsen universal testing machines, and it is accurate to about 0.003 inch. The yield point in this laboratory is taken, for non-ferrous metals, as the stress producing a deformation of 0.5 per cent, or 0.01 inch in the usual gage length of 2 inches. It will be readily seen that the above figures for proportional limit and yield point are low, even for bronze, and manganese bronze may rightly be claimed to show superior figures for the same properties.

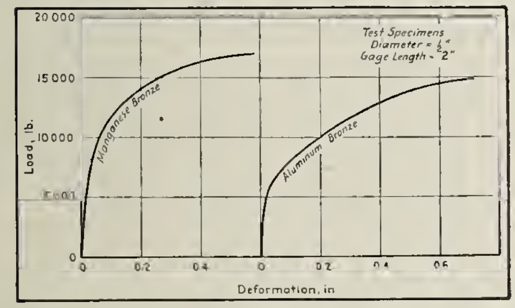


FIG. 1—LOAD DEFORMATION DIAGRAMS FOR TENSION TESTS

Many engineers, basing their design of machine parts or structural members on the elastic limit of the material used, in preference to its ultimate strength, might avoid aluminum-bronze and give preference to manganese-bronze on account of the better showing of the latter in a tension test. But in the great majority of cases, materials used in engineering construction are not subjected to uniform or slowly changing stresses as in a tension testing machine, but to alternating stresses, more or less suddenly applied, and varying in direction and intensity. The important point for an engineer to know, in most cases, is the life which a material will show under conditions of alternating stresses of small intensity, rather than the greatest possible load that may be applied without permanent deformation. As a matter of fact, machines and structures are never designed so that any of their parts are stressed up to their elastic limits, because it is known that such stresses repeated in practical use would cause very rapid failure in steel, ordinary bronze, etc.

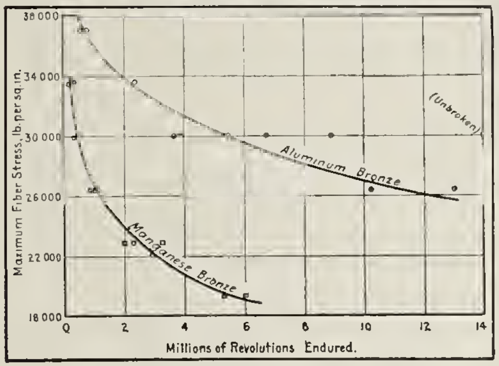


FIG. 2—STRESS ENDURANCE DIAGRAMS FOR WHITE-SOUTHER TESTS

Alternating and Repeated Stress Tests

To give more certain indications than are afforded by a tension test in regard to the life of a material under alternating and repeated stresses, many different types of endurance or fatigue testing machines have been used. In the opinion of many, a machine of this type, in order to be practical, must give quick results—that is, results obtainable in a few minutes, instead of a few days or weeks. A machine intended to satisfy this demand is the Landgraf-Turner alternating impact machine. The test specimen for this machine is a cylindrical rod ⅜ inch in diameter and 8 inches long. One end of the specimen is held rigidly during the test, while the other is bent backward and forward through a small angle by blows repeated 400 times per minute. The number of alternations endured before fracture is recorded automatically. Since fracture takes place close to the stationary end of the specimen, each end may be tested, and thus two tests obtained from each specimen. Some tests were made by the authors with this machine on three different types of bronzes and the results may be of sufficient interest to warrant reporting them in this paper.

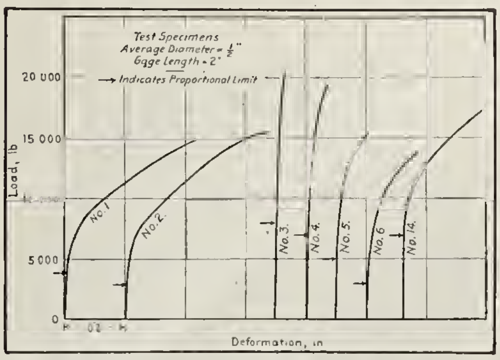


FIG. 3—LOAD DEFORMATION DIAGRAMS FOR TENSION TESTS, SHOWING EFFECT OF HEAT TREATMENT

Bars of our alloys Nos. 3, 5 and 29, ⅝ inch in diameter, were cast in sand for these tests and were machined accurately to a diameter of ⅜ inch. Alloy No. 3 is a phosphor-bronze containing 11 per cent of tin; No. 5 is a regular 10 per cent aluminum-bronze with 1 per cent of iron; and No. 29 is best-quality manganese-bronze, really a brass with 41 per cent of zinc, 1 per cent each of iron and tin, and about 0.5 per cent each of manganese and aluminum. As a preliminary trial one bar of each alloy was tested in the machine as used for steel, with a ¾-inch slot between the hammers that act on the test specimen. The results obtained, each the averaged number of alternations of two tests, were as follows: Alloy No. 3, 75; alloy No. 5, 4485, and alloy No. 29, 165.

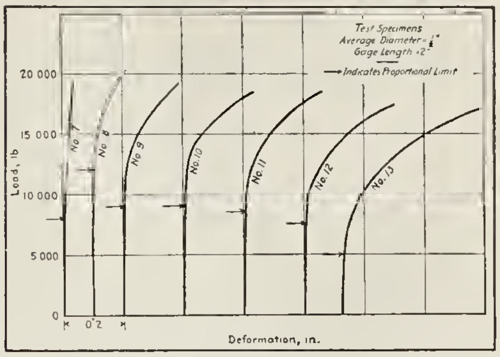


FIG. 4—LOAD DEFORMATION DIAGRAMS FOR TENSION TESTS, SHOWING EFFECT OF HEAT TREATMENT

Such low results for alloy No. 3 were shown, that it was thought best, for the sake of accuracy, to test this alloy with the machine adjusted as for malleable iron, with a 1-inch slot between the hammers. This makes the test less severe, as the angle through which the bar is bent at each alternation is considerably less than with the ¾-inch slot. The results obtained in this way, from

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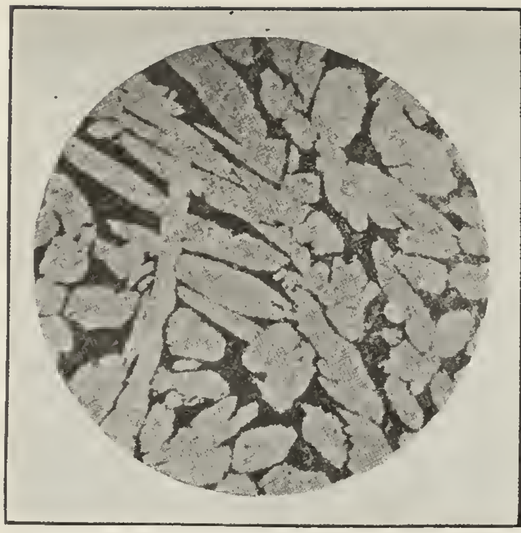
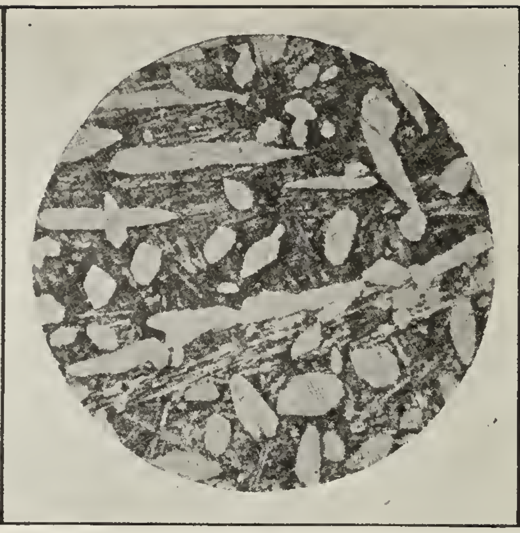
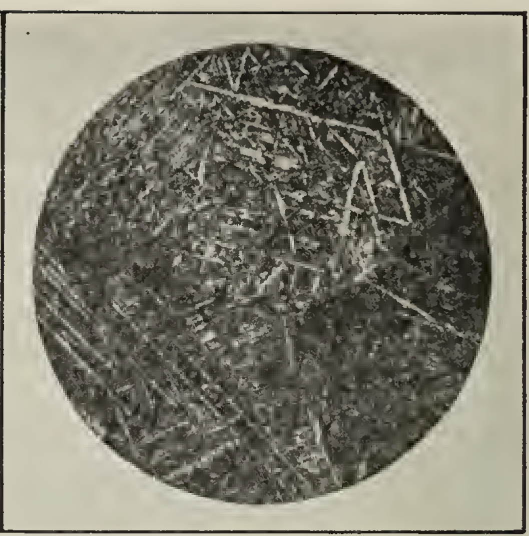
A paper read at the nineteenth annual meeting of the American Society for Testing Materials.







PHOTOMICROGRAPHS OF TEST SPECIMENS

Fig. 5.—Structure of specimen No. 1 cast in sand, not heat treated. Light alpha crystals in dark eutectoid

Fig. 6—A specimen quenched from 700 degrees Cent. Fewer alpha crystals in acicular beta

Fig. 7—A specimen quenched from 900 degrees Cent. Three grains of acicular beta, alpha entirely dissolved

nine bars that showed clean sound metal in their fractures, together with those obtained on an equal number of bars of malleable iron, tested under exactly similar conditions, are given in Table I.

Table I

RESULTS OF LANDGRAF-TURNER ENDURANCE TESTS, WITH 1-INCH SLOT BETWEEN HAMMERS

	Number of Alternations to Produce Failure		
Material	Maxi-mum	Mini-mum	Average
Alloy No. 3........	2,460	600	1,437
Malleable cast iron..	150	60	83

Table II

RESULTS OF LANDGRAF - TURNER ENDURANCE TESTS, WITH ¾-INCH SLOT BETWEEN HAMMERS

	Number of Alternations to Produce Failure		
Material	Maxi-mum	Mini-mum	Average
Alloy No. 5—			
10 good fractures	7,230	3,690	5,457
10 bad fracures..	5,910	3,540	4,983
All specimens ...	.....	.....	5,220
Alloy No. 29—			
3 good fractures.	1,050	750	910
3 bad fractures..	1,200	30	278
All specimens ...	.....	...	383

The specimens of alloys Nos. 5 and 29 were tested with a ¾-inch slot in the machine, and these results, therefore, may not be compared directly with those obtained for alloy No. 3. But as the ¾-inch slot is used for tests of steel, the results given in Table II are properly comparable to those obtained from steel axles and rails, which run from about 700 to 1,700 alternations. The highest number of alternations ever obtained from a steel in this laboratory was 1,715, from the head of an open-hearth rail. In making up this table, the results obtained from specimens showing good fractures were separated from those in which the fractures indicated defective metal, because some of the specimens of alloy No. 29 were defective.

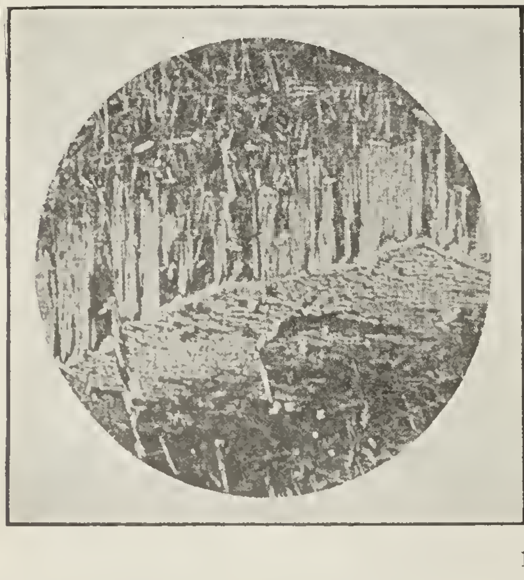
Consideration of Results

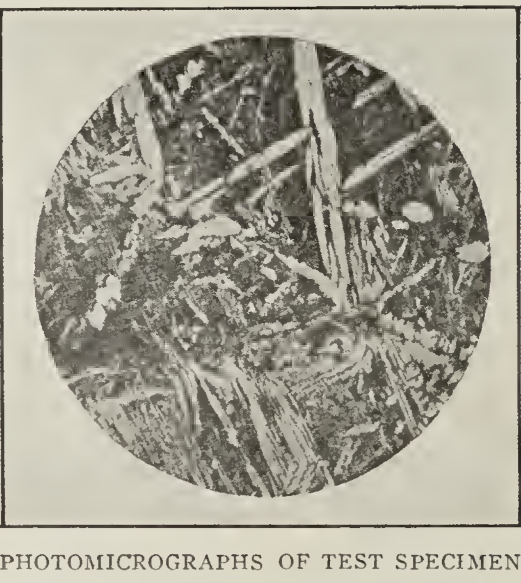
In considering the results, those from the good fracture of alloy No. 29 should be taken as representing this alloy, and they are seen to be within the range of ordinary steel. The results given by aluminum-bronze, alloy No. 5, are far superior to steel, however, and show that this alloy has a truly remarkable endurance of severe alternating stresses. Professor Arnold of Sheffield, England, found the same result in testing aluminum bronzes with a machine very similar to the Landgraf-Turner type, and reported to the authors of the eighth report to the alloy research committee of the British Institution of Mechanical Engineers that while the 9.9 per cent aluminum-bronze gave very good re-

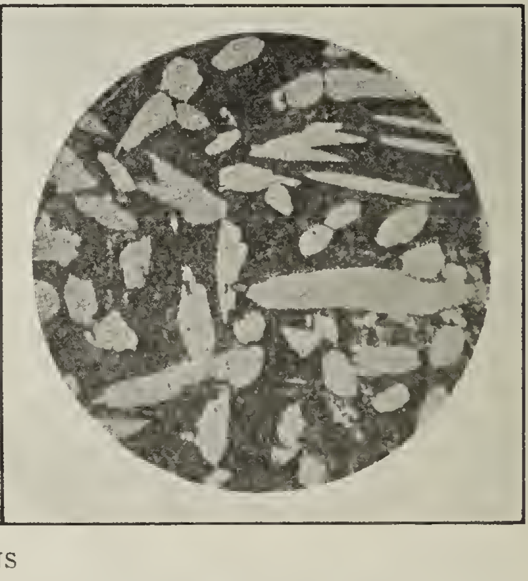
Table III

RESULTS OF WHITE-SOUTHER ENDURANCE TESTS

	Revolutions Endured before Fracture	
Maximum Fibre Stress lbs. per sq. in.	Manganese Bronze	Aluminum Bronze
37,100...........	....	562,800
	....	785,900
33,600...........	248,400	2,067,700
	277,000	2,371,300
30,000...........	....	3,687,900
	415,000	3,850,600
	423,200	5,446,900
	454,200	6,809,500
	....	9,578,800
	....	23,579,500
26,400...........	949,500	10,232,400
	1,074,800	13,106,600
	1,239,100	....
22,900...........	2,046,600	....
	2,363,500	....
	3,378,900	....
19,400...........	5,357,500	....
	6,080,000	....







PHOTOMICROGRAPHS OF TEST SPECIMENS

Fig. 8—Specimen No. 3 cooled in air 10 seconds before quenching. Growth of alpha along edges of beta grain

Fig. 9—Specimen No. 4 cooled in air 20 seconds before quenching. Alpha appears inside beta grains

Fig. 10—Specimen No. 5 cooled in air 30 seconds before quenching. Alpha collecting in big crystals like those in Fig. 5

sults, the 7.35 per cent alloy "constituted a record in its capacity of resisting alternations."

The question probably will arise as to why further tests were not made with this machine, especially on manganese-bronze, in view of the large number of defective specimens, and the answer to this inquiry would be that since a better, more trustworthy method of testing the endurance of these alloys was available, it did not seem worth while to repeat the less valuable tests. In the Landgraf-Turner machine, alternating stresses of high intensity are used exclusively, to shorten the time of the tests, and at every blow of the machine the elastic limit of the test specimen is exceeded and a permanent set is produced. These conditions are of course much more severe than are met with in the ordinary practical use of any metal. In order to show the probable life of a material in practical use, the test made on it should duplicate the conditions of such use as closely as possible, or in other words, the alternating stresses should be of low intensity, and preferably below the elastic limit of the material.

Tests With White-Souther Machine

Tests under these conditions have been made with our White-Souther machine, which operates on an entirely different principle from the Landgraf-Turner type. The White-Souther machine rigidly holds the test specimen, which is machined accurately to a special shape, in the axis of a wheel which is revolved at a speed of 1,300 revolutions per minute. The ends of the test specimen projecting on each side of the wheel are loaded with weights which hang constantly downward, so that each complete revolution of the wheel involves two reversals of stress in the specimen. This stress varies at any given instant of the test from a maximum value in compression at the under side of the specimen, to zero at the central axis, and then to a maximum value in tension at the upper side. The maximum value of the fiber stress may be easily computed from the known load applied at the end of the specimen, since the free length and diameter of the end of the specimen, which is the tested portion, are always made exactly the same, and can of course be accurately measured. A counter at each end of the machine records automatically the number of revolutions endured before fracture, and the machine is allowed to run continuously day and night until both ends of the bar are broken.

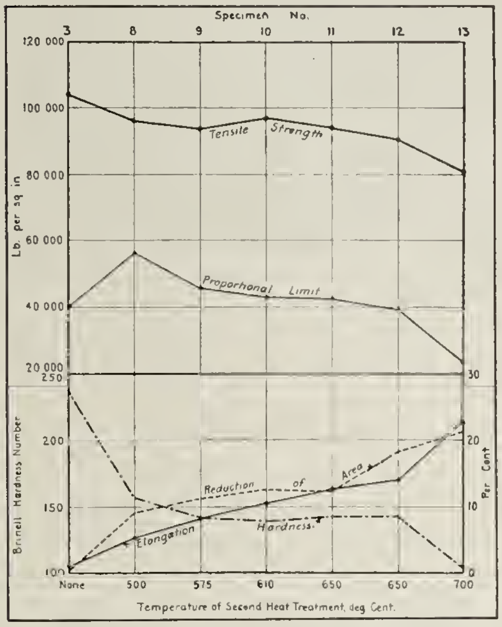


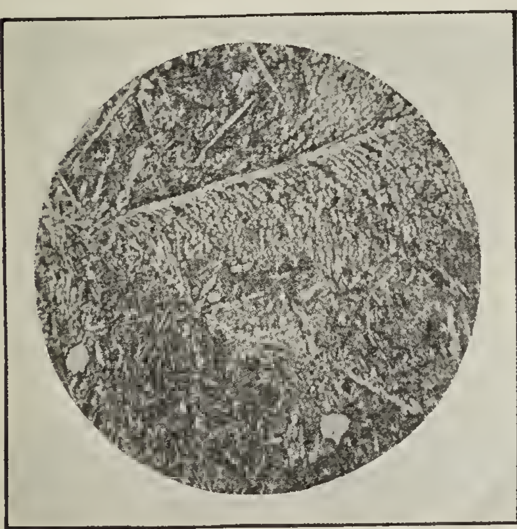
FIG. 11 — PHYSICAL PROPERTIES OF SPECIMENS ANNEALED AFTER QUENCHING FROM 850 DEGREES CENT.

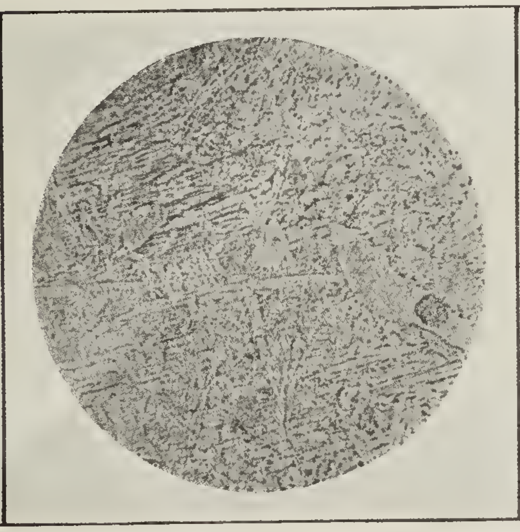
This test is essentially identical with the well-known Wohler endurance test. It is explained that a single endurance test made on each of two metals is not a good basis for judgment as to their behavior in actual service, for their comparative endurances at other stresses than that used in the test may be entirely different. For the same reason, alternating-stress tests made with the Landgraf-Turner or Upton-Lewis machines, where high stresses are used in order to shorten the time consumed in testing, are of small value even if a series of tests is made, for they do not indicate the endurance under stresses of low intensity. To determine the true safe range of stress, or the stress which a given material will resist indefinitely, it is necessary, according to Rosenhain, "to carry out a Wohler or similar alternating-stress test under at least three, but preferably four, different intensities of loading, so chosen that under the heaviest loading the test-bar breaks after a few thousand reversals, the subsequent loadings being diminished in such a way that under the last and lightest loading the bar either does not break or only does so after several million reversals. The results thus obtained are then plotted with the number of reversals endured as abscissas and the intensity of the stress as ordinates. It is found that the points so plotted lie on a curve of parabolic form which tends to become parallel to the axis as the intensity of the stress diminishes. The horizontal asymptote of this parabola is the limit of the safe range of stress to which the material may be exposed indefinitely under reversal, without risk of failure through fatigue."

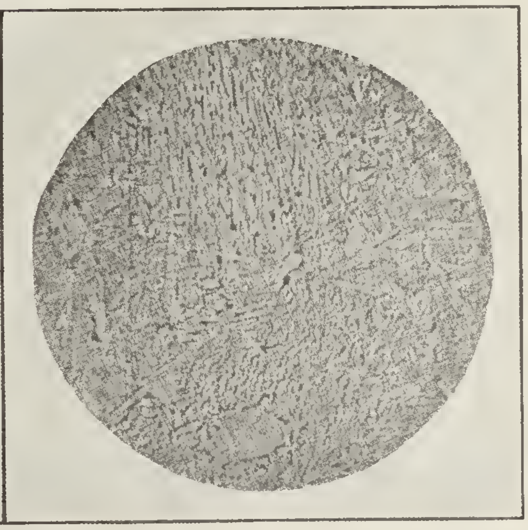
Fatigue Resistance

These precepts have been taken as a guide in making our White-Souther tests for comparing the fatigue resistance of aluminum and manganese bronzes, and while they have not been followed exactly, the departure from them has been on the safe side, so to speak, in that our tests were made with stresses which gave endurances running from a few hundred thousand to six or twenty-three million revolutions, or twice as many reversals of stress.

The material for these tests was cast half in sand and half in a chill, handled by regular methods, and in the form





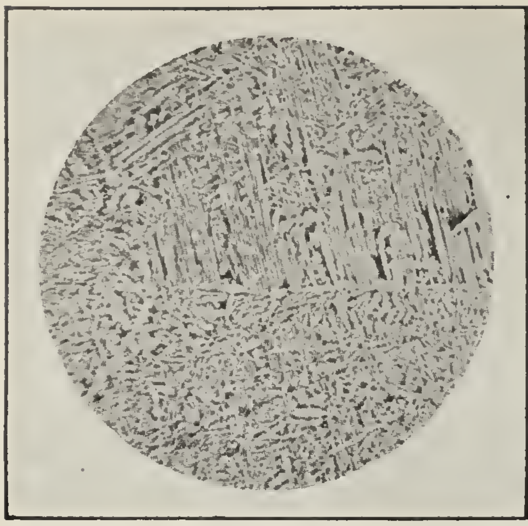


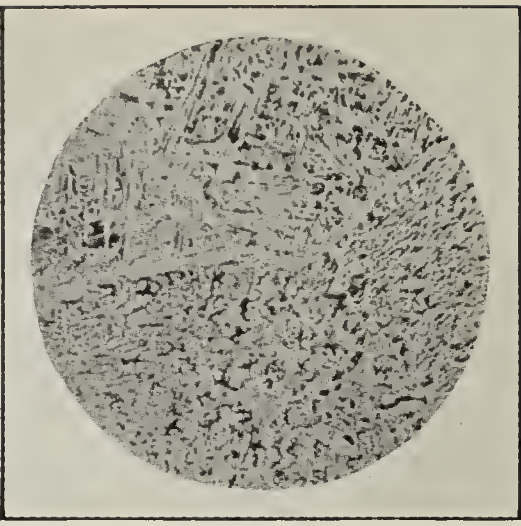
PHOTOMICROGRAPHS OF TEST SPECIMENS

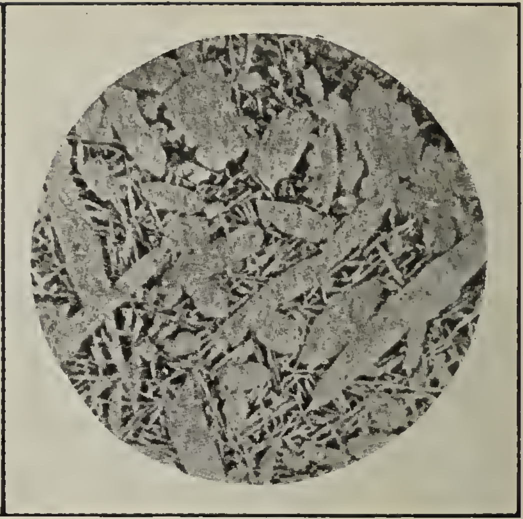
Fig. 12—Specimen No. 8 quenched, reheated to 500 degrees Cent. and cooled slowly. Beta slightly changed

Fig. 13—Specimen No. 9 quenched, reheated to 575 degrees Cent. and cooled slowly. Very fine alpha and eutectoid

Fig. 14—Specimen No. 10 quenched, reheated to 610 degrees Cent. and cooled slowly. Structure indistinct







PHOTOMICROGRAPHS OF TEST SPECIMENS

Fig. 15—Specimen No. 14 quenched, reheated to 650 degrees Cent. and cooled in air Structure more distinct

Fig. 16—Specimen No. 12 quenched, reheated to 650 degrees Cent. and cooled slowly. Coarser structure

Fig. 17—Specimen No. 13 quenched, reheated to 700 degrees Cent. and cooled slowly. Structure much coarser

of rods 1¼ inches in diameter and 18 inches long. Tension tests were made from one specimen ½ inch in diameter taken from the center of one such bar of each metal, and the results were as follows:

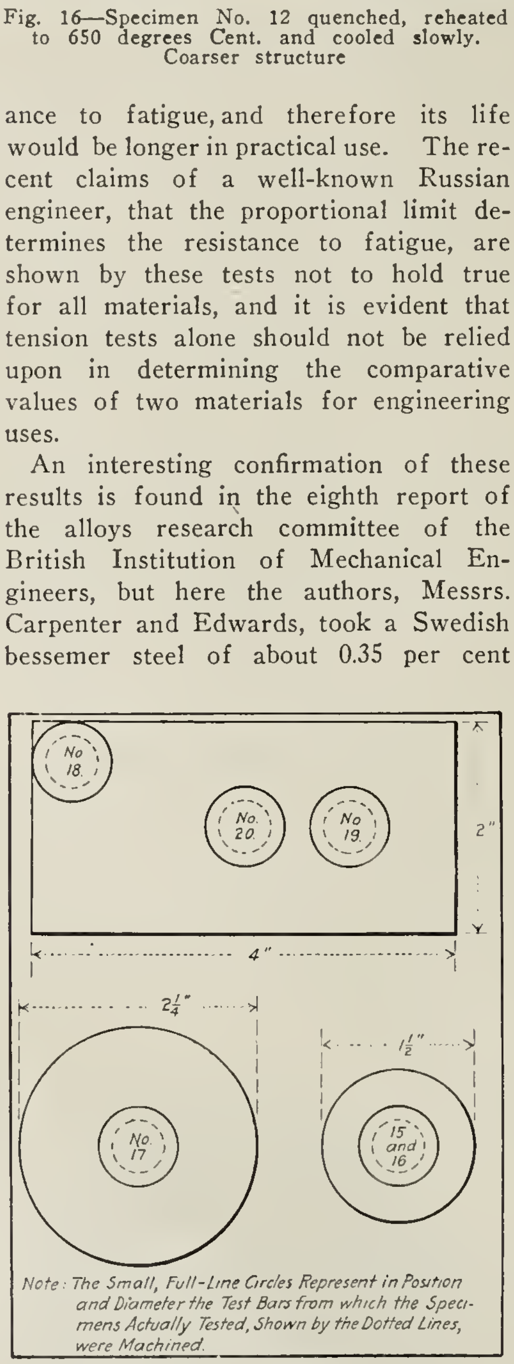
	Manganese Bronze	Aluminum Bronze
Proportional limit, lbs. per sq. in.	29,200	20.400
Tensile strength, lbs. per sq. in.	87,400	76,900
Elongation in 2 in., per cent	25.0	30.5
Reduction of area, per cent	25.2	27.6

The autographic load-deformation curves from which the proportional limits were obtained were carefully copied by tracing, and copies of them are shown in Fig. 1. It might be noted in this connection that the parts of the bars actually tested in the tension tests and the endurance tests were ½ inch in diameter, and were originally situated at the centers of the 1¼ inch round castings. The results of the White-Souther endurance tests on these alloys are given in Table III, and the curves plotted from them are shown in Fig. 2.

Owing possibly to the fact that the material tested was in the cast condition, and neither rolled nor forged, the results were somewhat irregular, and did not always check each other as well as might be desired. Low results caused by flaws in the specimens, or by undue vibration of the testing machine, were disregarded and not reported here. The one specimen of aluminum-bronze which endured over 23,000,000 revolutions before failure, at a maximum fiber stress of 30,000 pounds per square inch, must be considered of abnormal quality, since this extraordinary result was not checked in any other test, and this point was therefore not considered in plotting the curve shown in Fig. 2.

The results show clearly that aluminum-bronze, in spite of its comparatively low yield point and proportional limit as shown in a tension test, is far superior to manganese-bronze in endurance of alternating stresses, or resistance to fatigue, and therefore its life would be longer in practical use. The recent claims of a well-known Russian engineer, that the proportional limit determines the resistance to fatigue, are shown by these tests not to hold true for all materials, and it is evident that tension tests alone should not be relied upon in determining the comparative values of two materials for engineering uses.

An interesting confirmation of these results is found in the eighth report of the alloys research committee of the British Institution of Mechanical Engineers, but here the authors, Messrs. Carpenter and Edwards, took a Swedish bessemer steel of about 0.35 per cent carbon, instead of manganese-bronze, for comparison with 10 per cent aluminum bronze. A close similarity was found to exist between these two alloys in microstructure, hardening capacity, resistance to impact, endurance of alternating stresses, elongation and tensile strength. The similarity was also observed in the yield point, provided that "the true, not the primitive, yield point" is taken for the steel. This method of comparing the yield points of these two materials is justified by the authors of the eighth report in view of the work of Stanton and Bairstow, showing "that the primitive yield point," or yield point as determined in a tension test, "of a steel is usually an artificial figure, and is due to a stiffening caused by mechanical treatment in preparation" of the test specimen. Thus they found that the proper yield point of the bessemer steel mentioned was 15.2 tons per square inch, instead of 25.8 tons per square inch as was shown by a tension test. In the case of ten different irons and steels tested by Stanton and Bairstow for primitive yield point and maximum range of stress, between tension and compression, which could be endured for one million reversals, the ratio of primitive yield point to maximum range of stress was found to vary between 1.80 and 1.13. It is understood of course that if the primitive and true yield points were identical, this ratio would be 2.00. In the case of 10 per cent aluminum-bronze it was found to be 1.91, which means that there is, in the words of the eighth report, a "close approximation of the maximum stress, under which this alloy will bear an unlimited number of reversals, to the stress at the elastic limit as determined in a tensile test." Thus the yield point in tension of this aluminum bronze was found to be 14.8 tons per square inch, while the range of stress at which it would break after one million revolutions was calculated from several tests to be 28.3 tons per square inch, from which the ratio 1.91, as noted above, was obtained. This shows, quoting the eighth report again, that 10 per cent aluminum-bronze does "not show anything like the same tendency to assume an artificial yield point"



Note: The Small, Full-Line Circles Represent in Position and Diameter the Test Bars from which the Specimens Actually Tested, Shown by the Dotted Lines, were Machined.

FIG. 18—LOCATION OF TENSION SPECIMENS CUT FROM HEAT-TREATED CASTINGS. DOTTED CIRCLES SHOW PARTS TESTED

THE FOUNDRY DATA SHEET, JANUARY, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

TABLE OF CAUSES OF GRINDING WHEEL ACCIDENTS

PREPARED BY THE INDEPENDENCE INSPECTION BUREAU, PHILADELPHIA.

Broken wheels (caused by)	Cracked wheel (caused by)	Improper inspection of wheel	Before issued to operator. When being mounted.	
		Dropping or striking against some object while not being operated.	During storage While being mounted While standing	Carelessness. Horseplay.
		Being forced on improper sized spindle	Too small bushing. Too large spindle.	
		Heated Spindle	Tight bearings	Lack of oil. Improper spindle size.
			Inner flange not fixed on spindle.	
		Only one flange	Careless mounting. Ignorance.	
		Uneven bearing of flanges	Bent or broken flange or flanges Bushings projecting beyond sides of wheels High spots on flanges High spots on wheels	Improper specifications. Ignorance.
		Flanges of different diameters	Careless mounting. Ignorance.	
		Flanges not properly relieved	Entirely without relief Diameter of relief too small	Improper specifications. Ignorance.
		Compressible washers	Missing Too thin Too small diameter	Carelessness. Ignorance.
		Tightening of nut	Carelessness. Ignorance of mounter.	
		Hacking of wheel	Desire for increased cutting. No restriction on use of wheel.	
		Screwing wheel on taper arbor	Ignorance.	
	Too high rim speed (caused by)	Spindle overspeeded	Overspeed when first set up.	
			Speed increased	Desire for increased cutting. Thoughtlessly increasing speed of line shaft.
			Use of cone pulley	Shifting to small pulley: Desire for increased cutting. Loose shifter. Carelessness.
		Use of too large wheel for spindle speed	Wheel initially too large	Carelessness. Ignorance.
			Too large wheel substituted	Desire for increased cutting. Ignorance or indifference.
			Wheel of different grain and lower recommended speed substituted Wheel of different shape substituted Wet wheel substituted	Ignorance or indifference.

(*Continued on Data Sheet No. 226*)

TABLE OF CAUSES OF GRINDING WHEEL ACCIDENTS

PREPARED BY THE INDEPENDENCE INSPECTION BUREAU, PHILADELPHIA.

(*Continued from Data Sheet No. 225*)

Broken wheels (caused by)	Catching work between rest and wheel (caused by)	Improper adjustment of rest	Lack of attention. Ignorance.	
		Improper handling of work	Side grinding when rest not designed for it.	
			Pushing work under rest	Ignorance.
	Out of true (caused by)	Loose bearings	Lack of attention. Ignorance.	
		Bent spindle	Lack of attention. Ignorance.	
		Loose frame	Lack of attention. Ignorance.	
		Rough or improper use	Inexperienced men. Responsibility of foreman.	
	Unbalanced wheel (caused by)	Wheel standing in water (see under "cracked wheel"). Side grinding (see below). Wheel untrue.		
	Weakened wheel (caused by)	Wheel standing in water (see above). Side grinding (see below). Hacking wheel (see above).		
	Too small spindle (caused by)	Bushing too small in wheel Wrong spindle used for size of wheel	Ignorance or indifference.	
	Side grinding on improper wheel (caused by)	Lack of proper equipment. Inexperience of men. Indifference.		
Flying wheel, unbroken (caused by)	Mounted so that nut works loose (caused by)	Spindle threaded in wrong direction	Improper specifications.	
		Belt twisted so that machine runs opposite to initial direction	Equipment incorrectly erected	
		Motor reversed Spindle turned end for end	Ignorance.	
Work or dresser hurled out of workman's hand (caused by)	Caught between rest and wheel.	See above.		
Flying particles of emery, inhaled or in eye (caused by)	Exhauster defective (caused by)	Entire lack of exhauster	Exhauster not provided. Exhauster disconnected.	
		Exhauster line not proper size	Ignorance. Desire for saving expense.	
		Exhauster line stopped up	Not often cleaned. Poorly designed or constructed.	
	Eye protection insufficient (caused by)	No goggles provided.		
		Improper goggles provided.		
		Goggles not used	Prejudice. Carelessness. Fear of infection.	
	Chip guard defective (caused by)	No chip guard.		
		Chip guard not in use	Broken and not replaced. Prejudice of workmen.	
Flying pieces of broken revolving type of dresser (caused by)	No guard for dresser.			

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

that steel shows, and that its "inferiority is thus only apparent, not real" in respect to low yield point. In other words, it is the alternating-stress test that shows the true safe load that a material will stand in practical use, and with aluminum-bronze the yield point in tension shows about the same figure, or even lower according to our tests, while with ordinary steel and manganese-bronze the yield point as shown in a tension test is decidedly higher than the true safe load to be used in practice.

Heat Treatment of Aluminum-Bronze

It was noted previously that the alloys research committee report mentioned a similarity between 10 per cent aluminum-bronze and steel in hardening capacity. Both metals, when quenched in water from temperatures above about 800 degrees Cent., become much harder, have a higher yield point with very little ductility, and lose their duplex microstructure, which is transformed into a uniform mass of grains showing acicular or needlelike markings. This structure is known as martensite in steel, while in aluminum-bronze it is called the beta solid solution. It is well known that to obtain the best possible combination of strength and ductility in a piece of steel, two heat treatments should be given. The first is a quenching treatment to refine the grain and raise the strength and elastic limit, while the second is a cautious annealing to allow some of the normal transformations to take place and develop some ductility, without however giving sufficient time or heat to alter the fineness of the grain. A double heat treatment like this was thought to be worth trying on aluminum-bronze, in view of its similarities to steel, to see if the proportional limit could be raised without the loss of too much ductility, and with a possible increase also in the resistance to fatigue.

For some heat-treating experiments of this kind 25 tension test specimens were cast to size in sand from a single melt of our No. 5 aluminum-bronze alloy of the following composition: Copper, 88.63 per cent; aluminum, 10.67 per cent, and iron, 0.91 per cent. The specimens varied in diameter between shoulders from 0.493 to 0.521 inch, respectively, the length between shoulders being about 2 inches. The total length of the specimens was 9 inches and the diameter of the ends was about ¾ inch. The gage length of each bar was smoothed a little with a fine file where necessary, but no other machining was done before testing. The tension tests were made with an Olsen autographic machine of 100,000-pound capacity, but using a poise on the beam which gave a capacity of 50,000 pounds, thus increasing the refinement of the stress measurements. Autographic load-deformation diagrams were recorded for each test, and the proportional limits were obtained from these diagrams by noting the point where each curve began to deviate from its original nearly vertical direction. The yield point as usually determined with dividers would be slightly above this proportional limit in practically every case. Figs. 3 and 4 show accurate tracings of most of the autographic diagrams obtained in this work, and the point taken as the proportional limit is indicated in each case by a small arrow.

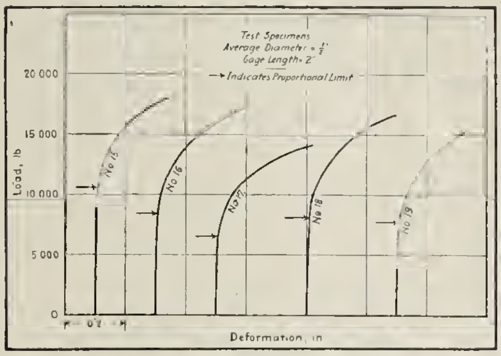


FIG. 19 — LOAD - DETERMINATION DIAGRAMS FOR LARGER SIZE SPECIMENS SUBJECTED TO DOUBLE HEAT TREATMENT

The curve for specimen No. 1 in Fig. 3 was obtained from one of the bars tested as cast, without any heat treatment. The results obtained were as follows:

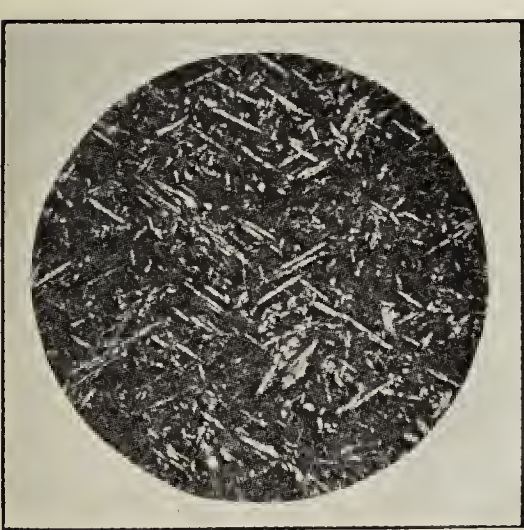
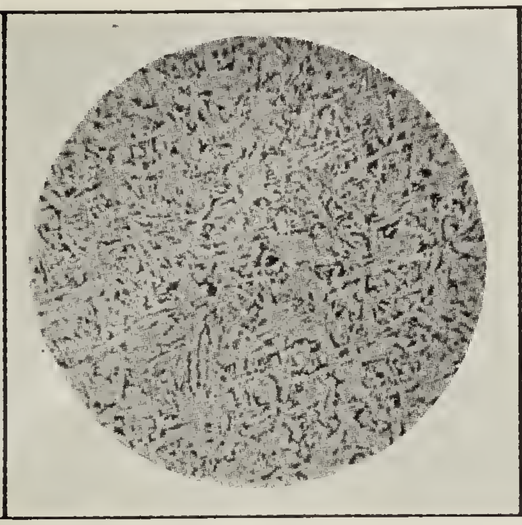
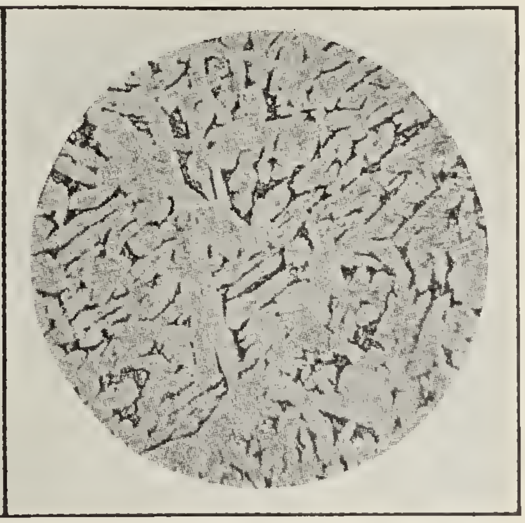
Proportional limit, lbs. per sq. in.	19,800
Tensile strength, lbs. per sq. in.	74,000
Elongation in 2 in., per cent	19.5
Reduction of area, per cent	23.7
Brinell hardness number	100

The hardness in each case was determined with a standard Swedish Brinell machine on a cross-section of one of the ends of the specimen after it had been subjected to the tension test. A load of 500 kilograms was used on every specimen except on Nos. 3 and 4, which were so hard that a heavier pressure was required and 3,000 kilograms were used.

A cross-section for microscopic examination was cut just beyond the shoulder of the bar, and the hardness specimen was taken next to it, so that both, though unaffected by the deformations of the tension test, were yet close enough to the tested portion to have experienced the same heat treatment. Fig. 5 shows the microstructure of this material as cast, the light grains being the alpha constituent, and the dark substance being beta according to the authors of the eighth report to the alloys research committee; but according to Gulliver and others, as seems more likely, it is a eutectoid, similar to pearlite in steel, of alpha and gamma. All the photomicrographs presented herewith show polished sections after etching with ferric chloride and hydrochloric acid, and all were taken with a magnification of 150 diameters.

Heat-Treatment

The heat-treatment was given in a small electrically-heated muffle, just long enough for the specimens, and about 6 inches wide, with a rounded roof 3¼ inches high. A new pyrometer of the Le Chatelier type was used to measure the temperatures, and it was found cor-

PHOTOMICROGRAPHS OF TEST SPECIMENS

Fig. 20—Acicular structure of bar 1½ inches in diameter, quenched in water from 950 degrees Cent.

Fig. 21—Similar bar reheated to 630 degrees Cent., showing fine structure

Fig. 22—Comparatively coarse structure of specimen No. 17, from center of bar 2¼ inches in diameter, after double heat treatment

rect for the melting point of lead. In every heating the test specimens were brought up to the desired temperature slowly with the furnace, and this temperature was maintained constant for a long enough time for thorough diffusion to take place.

It has been stated previously that this aluminum-bronze can be hardened by quenching from a high temperature, and the first tests were made to determine the proper temperature for alloy No. 5, and to show the effect of a short air cooling before quenching. Specimen No. 2 was quenched from 600 degrees Cent., and no hardening effect was noticed. Its stress-deformation curve is shown in Fig. 1 (marked "aluminum-bronze"), and the results from it were as follows:

Proportional limit, lbs. per sq. in.......	15,300
Tensile strength, lbs. per sq. in.........	79,600
Elongation in 2 in., per cent.........	21.0
Reduction or area, per cent..........	22.2

Table IV

RESULTS OF TESTS ON AIR-COOLED SPECIMENS.

Specimen No.	Time of air cooling, seconds.	Proportional limit, lbs. per sq. in.	Tensile strength, lbs. per sq. in.	Elongation in 2 in., per cent.	Reduction of area, per cent.	Brinell Hardness Number.
3........	10	40,500	105,200	1.0	0.8	262
4........	20	33,200	91,500	2.0	5.7	229
5........	30	23,600	73,200	5.0	9.4	150
6........	45	15,700	72,500	7.0	12.2	...

Table V

RESULTS OF TESTS ON SPECIMENS QUENCHED AND REHEATED AND COOLED SLOWLY IN FURNACE

(See also Fig. 11)

Specimen No.	Temperature to which heated. deg. Cent.	Time of heating, minutes	Proportional limit, lbs. per sq. in.	Tensile strength, lbs. per sq. in.	Elongation in 2 in., per cent	Reduction of area, per cent	Brinell hardness number
8............	500	30	56,700	96,100	5.5	9.1	158
9............	575	20	46,100	94,100	8.0	11.2	143
10...........	610	15	43,400	96,700	10.5	12.6	140
12...........	650	15	39,300	91,200	14.0	18.5	143
13*a*.........	700	15	23,400	80,000	23.0	21.7	104

a After cooling from 700 to 550 degrees Cent., specimen was withdrawn from furnace and cooled in air.

Table VI

RESULTS OF TESTS ON SPECIMENS OF LARGER SIZE SUBJECTED TO DOUBLE HEAT TREATMENT

Specimen No.	Original Size	Temperature of second treatment, deg. Cent.	Proportional limit, lbs. per sq. in.	Tensile strength, lbs. per sq. in.	Elongation in 2 in., per cent	Reduction of area, per cent
15.........	1½ in. diam.	600	53,600	93,300	10.0	13.5
16.........	1½ in. diam.	630	43,300	88,500	13.0	14.2
17.........	2¼ in. diam.	650	34,600	74,000	14.5	17.6
18.........	2 x 4 in. block	650	40,800	85,100	12.5	15.7
19.........	2 x 4 in. block	650	39,700	78,200	9.5	15.0
20.........	2 x 4 in. block	650	40,200*a*	74,700	9.0	13.5

a This value is for yield point instead of proportional limit, since no stress-deformation curve was obtained for specimen No. 20.

A specimen quenched from 700 degrees Cent. was spoiled by a casting flaw, but a photomicrograph, Fig. 6, showed that this temperature was not high enough. Although the dark constituent here shows the acicular markings typical of the beta solution, and has increased decidedly in quantity as compared with Fig. 5, there are still many crystals of soft ductile alpha that were not dissolved. Specimens quenched from 800, 900 and 1000 degrees Cent. were alike in structure, as is illustrated by Fig. 7, where the junction of three grains is shown, and all are composed of the beta solution with acicular markings well developed, and with all the alpha completely dissolved. A temperature of 850 degrees Cent. was adopted as the proper quenching heat for this material, and one of the specimens so quenched had the following physical properties:

Proportional limit, lb. per sq. in......	39,800
Tensile strength, lb. per sq. in........	97,400
Elongation in 2 in., per cent.........	1.0
Reduction of area, per cent..........	None
Brinell hardness number..............	240

The stress-deformation curve for this specimen is that of specimen No. 7 in Fig. 4.

Four tests were made to find the results of air cooling for different periods between the heating at 850 degrees Cent. and the quenching in water. Specimen No. 3 was thus air cooled for 10 seconds before quenching; specimen No. 4 for 20 seconds; specimen No. 5 for 30 seconds; and specimen No. 6 for 45 seconds. The stress-deformation curves are shown in Fig. 3, and indicate plainly that this treatment lowers the elastic limit of the quenched material with only a slight increase in ductility. The curve of specimen No. 6 would probably have been longer if a flaw had not existed in the casting. The physical properties of these bars are given in Table IV.

These tests show that if 10 seconds elapse between the withdrawal of a small specimen of this alloy from a furnace at 850 degrees Cent. and its immersion in water, the quenching effect will not be lessened. The allowable time will of course vary with the size of the specimen and the temperature of the air. Nothing is gained by intentional air cooling before quenching. The microstructures of these specimens, Figs. 8, 9 and 10, are rather interesting. Fig. 8 shows the boundary between two grains in specimen No. 3, where the light alpha constituent is beginning to separate, or to be precipitated, from the acicular beta. In this case there was not enough air cooling for very much alpha to form, but in Fig. 9, showing specimen No. 4, which was air-cooled 20 seconds before quenching, the alpha crystals are much more extensively developed not only at the boundaries but inside the beta grains as well. Fig. 10, showing specimen No. 5, is a close approach to the original cast structure of this material, Fig. 5, with less alpha however and plainer acicular markings in the dark constituent.

Some tests were next made on specimens reheated after quenching from 850 degrees Cent. A few preliminary treatments of small specimens followed by microscopic examinations indicated 650 degrees Cent. as a good temperature for the annealing. Two specimens were therefore reheated, after quenching, to this temperature for 15 minutes, and one was then withdrawn from the furnace and air-cooled, while the other was left to cool very slowly in the furnace. Physical tests on these bars gave the following results:

	Air Cooled	Cooled in Furnace
Proportional limit, lbs. per sq. in.	35,100	32,900
Tensile strength, lbs. per sq. in.	86,600	94,000
Elongation in 2 in., per cent..	13.0	12.5
Reduction of area, per cent..	14.9	12.3
Brinell hardness number	130	143

The stress-deformation curve of the air-cooled specimen is that for specimen No. 14, Fig. 3, and of the furnace-cooled specimen No. 11, Fig. 4. These results are very surprising in that the specimen which was cooled faster, in air, was less strong, more ductile, softer, and lower in proportional limit than the specimen cooled very slowly in the furnace. This remarkable fact was checked several times by hardness determinations on different small specimens similarly heat-treated, and always the furnace-cooled specimen was harder than the air-cooled one. As the object of this work was to find a way of raising the elastic limit of this material without destroying its ductility, it seemed evident that the furnace-cooled specimen came closer to satisfying this requirement than the one cooled in air.

A final series of tests was made on quenched specimens reheated to different temperatures between 500 and 700 degrees Cent., and cooled slowly in the furnace. Specimen No. 8 was heated to 500 degrees Cent. for about 30 minutes; specimen No. 9 to 575 degrees Cent. for about 20 minutes; specimen No. 10 to 610 degrees Cent. for 15 minutes; specimen No. 12 to 650 degrees Cent. for 15 minutes; and specimen No. 13 to 700 degrees Cent. for 15 minutes, and then this specimen was withdrawn from the furnace at about 550 degrees Cent., and cooled in air. The results of tests on these bars are given in Table V.

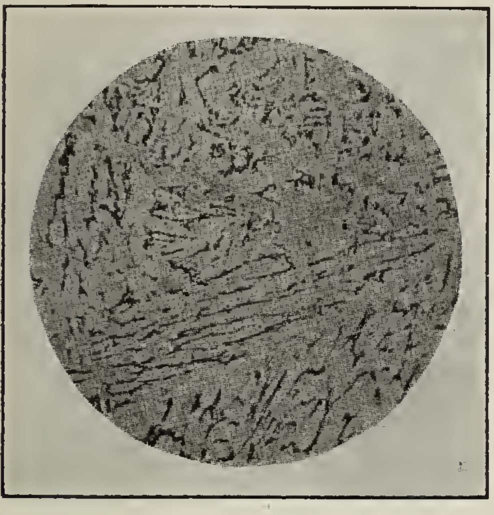


FIG. 23 — STRUCTURE OF SPECIMEN NO. 18, FROM CORNER OF 2 x 4-INCH CASTING AFTER DOUBLE HEAT TREATMENT

These results are plotted in Fig. 11, together with the results from specimen No. 11, previously given, a duplicate of No. 12 in respect to heat treatment; and also with the results from specimen No. 3, considered as a quenched bar without the second heat treatment, to form the starting points for the curves. The physical properties of specimen No. 3 are shown in Table IV. A duplicate of specimen No. 10 was also tested, but is not included here because its results were almost exactly the same as those from specimen No. 10. The stress-deformation curves of these specimens are shown in Fig. 4.

Table VII

ENDURANCE TESTS OF HEAT-TREATED ALUMINUM-BRONZE SPECIMENS

Maximum Fiber Stress lbs. per sq. in.	Revolutions Endured before Fracture
40,600	882,600
	1,431,800
	4,538,400[a]
37,100	1,730,700
	2,662,100
	7,088,000
33,600	5,432,100[b]
	5,770,800
	29,750,900

[a] See Fig. 21 for photomicrograph.

[b] This bar was machined 0.003 in. too small.

Some specimens which had been heat-treated with those whose results are given in Table V were sent to the bureau of standards and there tested. Small flaws were reported in all of them, however, and therefore the results were not as good as they should have been. One specimen heat-treated similarly to specimen No. 12 was reported by the bureau to have given the following results, which are in good agreement with those found here:

Proportional limit, lbs. per sq. in.	40,000 to 45,000
Tensile strength, lbs per sq. in.	88,500
Elongation in 2 in., per cent.	15.0
Reduction of area, per cent...	17.3

The microstructure of specimen No. 8, shown in Fig. 12, has a good deal of the acicular structure remaining, but with some feathery precipitation of alpha in fine particles along the grain boundaries, and a few larger masses within the grains. In the following photomicrographs the acicular structure has entirely disappeared. Specimens Nos. 9 and 10, Figs. 13 and 14, respectively, had practically the same structure, but with a few larger grains in specimen No. 9 due perhaps to the slightly longer period of annealing. It will be noted that both these photomicrographs are rather indistinct, and show a very fine grain structure of light alpha crystals with a dark constituent between them. The indistinctness is partly due to the fineness of the structure, partly to the great difficulty of polishing this material without scratches, and partly to the fact that the etching reagent shows a much greater tendency to attack these small crystals of alpha than it does with the ordinary coarser structures. Specimen No. 11 had a structure similar to these, and the structure of No. 14, the air-cooled specimen, is shown in Fig. 15. This structure is much more distinct and apparently coarser than those of the furnace-cooled bars heated to the same temperature. It may be seen, however, that the different grains show different degrees of fineness of their crystals, and the greater coarseness of the air-cooled sample is thus probably more apparent than real. But the greater distinctness of the air-cooled structure cannot be questioned, although all the samples were polished and etched in the same way. Perhaps the very slow cooling in the furnace through low temperatures causes a certain diffusion of the dark constituent into the lighter alpha, as some action like this would explain the greater hardness of the furnace-cooled metal as well as the indistinctness of its structure. Or it is possible that there is some hardening transformation in either the alpha or the dark constituent or both at a low temperature, below a red heat, which is prevented or decreased by air-cooling. The eighth report to the alloys research committee mentions an increase in yield point and decrease in ductility that takes place in this alloy after annealing at 400 degrees Cent., but with no apparent change in the mocrostructure.

Specimen No. 12, supposed to be a duplicate of specimen No. 11, had quite a decidedly coarser structure, and its physical properties also indicated a more complete annealing than specimen No. 11 had received. Its structure is shown in Fig. 16, where corners of four different grains are included. Each grain has its own typical arrangement of crystals, but on the whole the structure appears similar in type to that of specimen No. 9 or No. 10, although the texture is coarser. In Fig. 17 the structure of specimen No. 13 is shown, and it is seen to be entirely different, just as its physical properties are so different from those of specimens Nos. 9 and 10, and even No. 12. Coarse crystals of alpha are here present, as in the cast metal, but the ground-mass shows also some finer needles of alpha, having an appearance somewhat like Fig. 15. The coarse crystals probably grew while this bar was in the furnace at temperatures between 650 and 700 degrees Cent.; and when it was air-cooled below 550 degrees Cent. a little more alpha was precipitated from the dark constituent, but did not have chance to unite with the larger crystals because of the low temperature, and hence re-

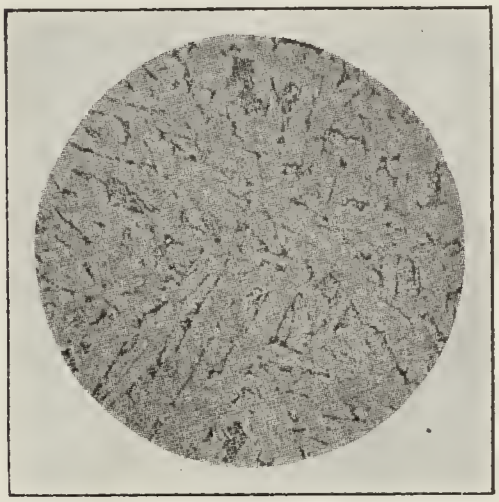


FIG. 24 — STRUCTURE OF SPECIMEN NO. 20, FROM CENTER OF SAME CASTING AS SPECIMEN NO. 18

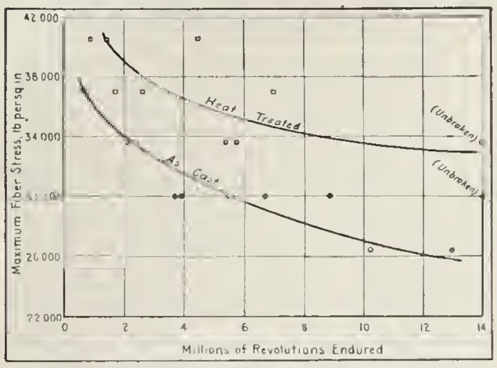


FIG. 25—STRESS-ENDURANCE DIAGRAMS FOR WHITE-SOUTHER TESTS ON ALUMINUM BRONZE

mained in finer particles along the cleavage planes of dark constituent.

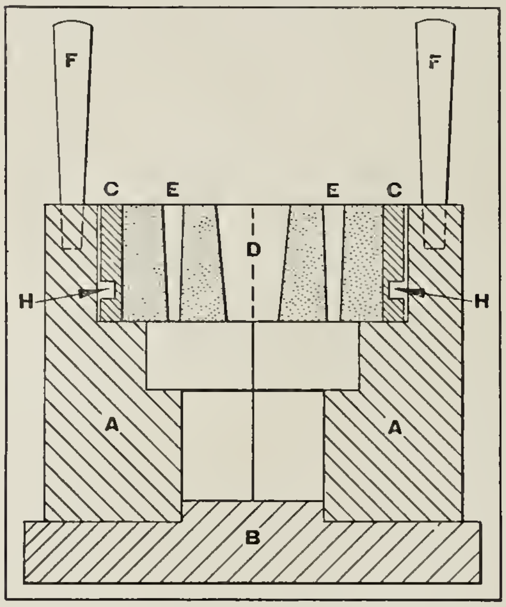
This work on heat-treatment has been described in some detail because it is not believed to be generally known that aluminum-bronze is nearly as susceptible as steel to improvement in this way. At the time when the experiments were made the double heat treatment, that is, quenching followed by tempering, was thought to be something new for bronzes, but subsequently a paper was found, in the proceedings of the French Academic des Sciences where similar results were reported by two investigators in 10 per cent aluminum bronze treated by the same processes that we have described. They however tried a wider range of tempering temperatures than we used, and their report emphasizes the remarkable fact that a tempering to only 400 degrees Cent. made their specimens actually harder than they were after quenching. Reheating to above 400 degrees Cent. was necessary to obtain any softening effect after quenching.

Application of Heat-Treatment to Larger Castings

The favorable results obtained by a double heat-treatment of the small cast-to-size bars naturally raised the question as to whether a similar improvement could be brought about when the method was applied to castings of larger size. A rectangular block 2 x 4 x 9 inches was cast for an experiment to determine this point, and tests were made also with one bar 2¼ inches in diameter and two bars about 1½ inches in diameter. These represent cross-sections as large as the average castings for gears, bearings, etc., though of course the total mass of metal was not as great in any of them as in many of the regular castings made of aluminum-bronze.

The pieces of the sizes mentioned were quenched and reheated to 650 degrees Cent., except the 1½-inch round bars which were tempered at 600 and 630 degrees Cent. Afterward test bars were cut from the centers of all the pieces, and also from the corner and midway between the center and edge of the rectangular block, as shown by Fig. 18. The specimens were machined from these test bars to the same size as the cast-to-size bars previously treated, and tested in the same way. The results are given in Table VI, the bars being numbered in the same way as their locations in Fig. 18, and their load-deformation curves (except for specimen No. 20) are shown in Fig. 19.

These results indicate that the double heat-treatment improves large castings in about the same way as small bars, although the values finally obtained with the large castings are of course not so good as those obtained from small ones. The great trouble in treating a large casting seems to lie in the impossibility of chilling it quickly enough in water to refine the grain properly. The scleroscope hardness after quenching should be between 55 and 60. Fig. 20 shows the microstructure of a 1½-inch round bar that was properly quenched, but to obtain this result it was necessary to be very quick with the quenching. Fig. 21 shows the structure of a bar similar in all respects to specimen No. 16, and the structures of specimens Nos. 17, 18 and 20 are shown by Figs. 22, 23 and 24, respectively. Although the latter structures are much coarser than that seen in a small treated casting, they are nevertheless finer and quite different from that of a casting that was not heat-treated (Fig. 5). Specimen No. 17 had a coarser structure than specimens Nos. 18 or 20, probably because it was not quenched so quickly, and that is the reason its proportional limit was lower and its ductility higher than in the other specimens. It should be noted that the differences between the center and edge of the rectangular block are not excessive either in structure or properties and at both locations there are marked improvements in both proportional limit and tensile strength over the propertics usually found in a large untreated casting.



CROSS-SECTION OF PERMANENT IRON MOLD FOR NON-FERROUS METALS

The chief advantage gained by heat treatment of aluminum-bronze as described above is in raising the proportional limit without the sacrifice of a necessary amount of ductility. This might be a great advantage in itself for some purposes, but, as stated in the first part of this paper, for most engineering uses the life of a material under alternating stresses is more important than its capacity for resisting a single slowly applied force. Hence the good results in tension obtained from aluminum-bronze by the double heat treatment would be of much greater interest, if they could be shown to imply a better endurance of alternating stresses as compared with that of an untreated casting. A few tests of heat-treated bars have been made for this purpose with the White-Souther endurance testing machines, the bars, about 1½ inches round, having been cast in the usual way, and heat-treated before machining to test specimen size. The results are plotted as shown in Fig. 25, together with the endurance curve for the same alloy untreated; the numerical values are given in Table VII.

The last value in Table VII, namely, 29,750,000, is probably somewhat better than could ordinarily be expected for this material, but all the results are a decided improvement over those obtained from the same alloy as cast, without heat-treatment, and show that the finer grain of the heat-treated material gives a greater endurance of alternating stresses as well as higher strength and proportional limit in tension. While many steels would, of course, give better results than these, no non-ferrous alloy has ever been reported, so far as we know, that would approach aluminum-bronze in this respect. It should be remembered, moreover, that all the results reported were obtained from unworked bars that had been neither forged nor rolled.

Chill Molds for Casting Non-Ferrous Metals

Of the three materials suitable for the casting of non-ferrous metals in chill molds, gray cast iron and steel have been used and found satisfactory. The third material is malleable cast iron. Cast iron molds should be produced with a generous allowance for machining to the exact dimensions required for the production of a casting, and also for the removal of surface defects. The thickness of the walls of the mold depends upon its size. For small castings the walls need not be more than 2 inches thick. Steel molds may be thinner.

Whether the parts of the mold form vertical or horizontal joints, strong clamps, of a simple type adapted to rapid tightening and loosening, should be provided. If the parts of the mold are hinged together, the hinges should work smoothly and easily. Strict attention should be paid to the venting of the joints, for if there is insufficient provision for the escape of air the casting will be either spongy or its surface will be spoiled by the presence of air pockets.

The composition of the iron for cast iron molds is important. The iron should be tough and close-grained and free from blowholes.

An abstract of a paper read before the Birmingham branch of the British Foundrymen's Association.

The following composition of iron has been recommended for molds:

	Per cent.
Combined carbon	0.84
Graphitic carbon	2.76
Silicon	2.02
Sulphur	0.07
Phosphorus	0.89
Manganese	0.29

The high phosphorus content is justified on the ground that the fluidity which it confers enables molds of sharper outlines to be produced. However, an iron high in combined carbon would probably grow and become deformed under repeated heating. The presence of phosphorus, moreover, increases brittleness, and therefore a cast iron with a low phosphorus content is preferable, for even if sharp outlines are not obtained, the surface can be machined.

To protect the mold surface and to facilitate the extraction of the casting, a coating is applied. Seal oil liberally mixed with fine plumbago appears to be as satisfactory as anything. In contact with the molten metal partial distillation of the dressing takes place, with the production of gaseous hydro-carbons which are tapped in the casting before they can gain egress from the mold. Just sufficient coating is required to form a gaseous envelope between the casting and the mold to give a clean surface to the former, to facilitate its extraction and to protect the surface of the mold. If carbonaceous coatings are considered undesirable, an emulsion of bone ash and water applied with a brush to the warm surface of the mold should prove satisfactory and will give good results.

Steel scores appear to be preferable to sand cores in iron molds. The provision of a satisfactory gate for chill molds has introduced difficulties. Owing to the rapid chilling effect of the iron no marked constriction of space at the junction of the head with the casting can be allowed, as the setting of the metal is likely to take place here before the casting has solidified. By carefully diminishing the rate of pouring as the mold fills, this difficulty may be partly overcome. The writer tried to use a small head, kept molten until after the solidification of the casting. To do this the gate was made in sand in a detachable ring placed on top of the mold, and kept firmly in position while pouring. The lower thermal conductivity of the sand enabled the small head to do all the feeding. A small riser was also added for the purpose of securing free egress of gas and air from the mold. In the accompanying illustration the halves of the mold are indicated by *A; B* is the cast iron base and *C* the steel ring for sand. The gate is shown at *D; EE* are the risers and *FF* the handles. The small heads proved that the feeding was satisfactory. In one experiment the weight of the head represented only 8 per cent of the total weight of metal used. This method also has the advantage of securing a more effective elimination of dross, air and gas.

COMPARISON OF THE PHYSICAL PROPERTIES OF ALLOYS CAST IN SAND AND PERMANENT MOLDS

Composition, per cent.	How cast.	Yield point, tons per sq. in.	Breaking stress, tons per sq. in.	Elongation, per cent.
Copper, 85; aluminum, 5..	Sand	4.3	18.1	75.0
Copper, 85; aluminum, 5..	Chill	7.1	18.1	60.5
Copper, 90; aluminum, 10..	Sand	11.3	31.7	21.7
Copper, 90; aluminum, 10..	Chill	12.4	36.93	30.5
Copper, 88; aluminum, 10; manganese, 2..	Sand	13.2	34.44	24.0
Copper, 88; aluminum, 10; manganese, 2..	Chill	16.8	37.0	25.0
Copper, 56; zinc, 41; iron, 1.5; tin, 0.9; alum., 0.45; manganese, 0.15 ..	Sand	....	33.44	20.0
The same alloy as given above.	Chill	....	38.4	25.0

In producing brass castings in chill molds, the elimination of dross from the surfaces of the casting has proved to be the greatest difficulty. The position of the mold has some bearing on the problem. The best way to secure castings with smooth cleaning surfaces is to prevent ingress of all dross and oxide to the mold. A suitable flux which will dissolve zinc oxide is useful. The addition of aluminum to copper-zinc alloys has the effect of checking oxidation of the zinc, and no other deoxidizer has been proved to have such a marked influence in this respect.

To prove that dross was the cause of rough surfaces, the following experiment was made. A graphite crucible was pierced at the bottom with a ¼-inch hole, and a ½-inch arc-light carbon was used to plug up the

(*Continued on page 37*)

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Porous Brass Castings

An unusually large number of our castings have been unsatisfactory recently, due to porosity, and we believe this is caused by using copper turnings in our mixture, which are obtained from copper bands for shells. We have had them analyzed and they contain over 99 per cent electrolytic copper. Do you think this material could be melted satisfactorily? We manufacture plumbers', steamfitters' and engineers' supplies.

Copper turnings may be melted satisfactorily provided a copper bath first is obtained in the bottom of the crucible into which the turnings can be stirred. With your metal analyzing 99 per cent copper, it cannot be considered a pure metal, but silicon and aluminum are the only impurities that might cause trouble. The analysis should show that these are present. Approximately 0.10 per cent silicon will cause trouble in brass containing lead. The copper can be cleaned in the crucible, but the method cannot be described adequately, since unusual mechanical skill is required to restore the copper after the impurities have been oxidized. If neither silicon nor aluminum is present, the copper can be used satisfactorily for plumbers' brass goods, including steamfitters' supplies, etc. All that is necessary is careful melting.

Melting Down Scrap

We are contemplating the use of scrap metals in some of our work and before using it for casting purposes we desire to run down a small quantity, say 2,000 or 3,000 pounds, to get the analysis. Kindly advise us what type of furnace would be satisfactory for this work? Also, could the metal be refined to some extent while being run down and if so, what would be the proper procedure?

A number of oil-fired, open flame furnaces are built which will satisfactorily meet your requirements. A cupola would not meet the needs of this work, as the metal comes into intimate contact with the fuel and being air-driven, is under pressure and will absorb sulphur from the coke and oxygen from the air. A reverberatory furnace also is an excellent medium for melting scrap in bulk. The metal can be refined if necessary. If the contamination is aluminum, this can be removed by oxidation, but it would not be advisable to remove lead, tin or zinc, as these metals can be utilized when using the ingot to make the various alloys used in the foundry. If it is necessary to carry on much refining, it would be advisable to engage the services of a man familiar with the work.

Cleaning Solution for Brass Castings

What is the best solution to use for cleaning brass castings?

An excellent dip for removing sand from brass castings follows: Muriatic acid, 6 gallons; nitric acid, 1 gallon and water, 2 gallons. Leave the castings in the dip until the sand is loosened, then remove them and rinse in water. However, the sand blast is the best medium for cleaning brass castings.

Difficulties in Making Brazing Brass

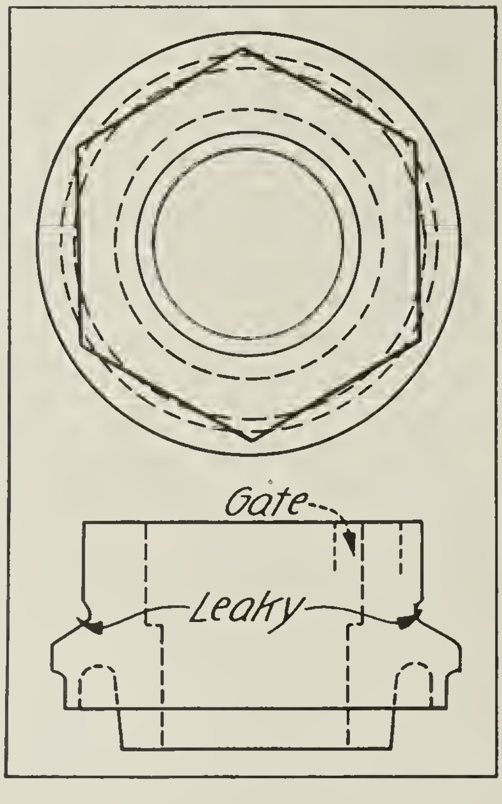
In making brazing brass containing 16 parts copper and 3 parts zinc, the metal becomes mushy and the skimmings contain an unusually large percentage of metal. How can this be overcome? Also, how can I treat the skimmings to recover the metal? Can you give me a suitable mixture for brass blow-off valves for marine boilers to withstand 190 pounds steam pressure? Kindly give me a standard formula for manganese-copper and also for silicon-copper. Can you recommend a good mixture for valve stems which must be strong? Also, what is a good deoxidizer to use when making valve stems?

If the zinc is added to the molten copper in the form of a yellow brass of known composition, such as an alloy of 50 per cent copper and 50 per cent zinc, much better results can be obtained than when it is added alone. Use powdered charcoal and salt to reduce the mushy metal in the crucible and deoxidize with manganese-copper. Clean the skimmings and melt with salt, charcoal and borax at a high temperature. The following alloy is suitable for valves: Copper, 87 per cent; tin, 6 per cent; lead, 2 per cent, and zinc, 5 per cent. Manganese-copper contains 30 per cent of manganese and 70 per cent of copper and can be made by melting manganese and copper together. The silicon copper usually contains 10 per cent of silicon and 90 per cent of copper. For valve stems use copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent. Phosphor-copper is an excellent deoxidizer when used properly.

Aeroplane Metal

We would like to know what mixture is used to make aeroplane castings for the British army. Recently I have come into competition with this metal to be used for aluminum castings for bakers' machinery and it is claimed that the aeroplane metal is superior to the mixture I am using. I have obtained excellent results from a mixture containing 80 per cent aluminum, 18 per cent zinc and 2 per cent copper.

Aeroplane metal is the name of an aluminum alloy patented in England in 1903 by F. W. Green and T. Prescott. The patent specifications give its composition as follows: Magnesium, 6.5 to 15 per cent; cadmium, 2.5 to 10 per cent, and aluminum, 91 to 75 per cent. The alloy containing the higher proportions of cadmium and magnesium would be too hard and brittle for your use and, therefore, it would be advisable for you to experiment with one containing a minimum percentage of these metals.



BRASS CASTING INSUFFICIENTLY FED

Difficulty Due to Insufficient Feeding

We have experienced unusual difficulty in obtaining sound castings similar to the one shown in the accompanying illustration. When subjected to 250 pounds pressure, these castings almost invariably leak at the points indicated on the sketch. We have tried several different mixtures without overcoming this trouble. Can you suggest a method for eliminating these defects?

Your trouble is due to insufficient feeding. It can be remedied by providing a metal reserve back of the gate from which metal will flow to fill the voids left between the crystals due to the drainage of the eutectic to other parts of the casting that solidify before that portion which becomes defective. To obtain a better understanding of the cause of your trouble, cut a section from the defective portions of the casting and another section from a sound portion and have microphotographs made from these samples. The defective sample will be found to consist of crystals minus the blue eutectic at their juncture, or crystals that touch at some points and not at others, leaving spaces through which liquids will percolate easily. Provide a sufficient metal reserve to feed the castings and incline the molds so that the eutectic in the reserve metal can seep through the crystals to the vacant places in the casting.

Trying to Use Poor Scrap

I have charge of a normal training school foundry and I experience considerable difficulty in obtaining satisfactory raw material for making brass castings. Only scrap is provided, which is of the poorest grade and consists of the tops and bottoms of wash boilers, zinc wash boards and fruit jar covers, lead pipe, tin pipe from soda fountains and scrap of the gas fixture variety. It is almost impossible to obtain castings free from blow-holes. In melting, a generous amount of charcoal is used to prevent oxidation and ground glass also has been employed. In charging charcoal, a half a dry battery is placed in the bottom of the crucible filled with copper and after this is molten, the tin is added, followed by the lead and just before pouring, the zinc is introduced. The latter, however, owing to the thin nature of the scrap, oxidizes rapidly and I wold like to know how this can be introduced to reduce this oxidation to the minimum.

The best method of utilizing the zinc scrap is to melt it separately and to run it into ingots. To accomplish this the thin scrap should be pounded together and should be charged into an old crucible, two-thirds full. This pot should be placed in a furnace and the contents melted. When the scrap becomes soft, push it down into the crucible so as to get a puddle of molten zinc in the bottom of the pot, then add more scrap into this molten metal, feeding the crucible as rapidly as the scrap is melted. As the bath grows in size, the process can be carried out more quickly, and when the pot is full it should be removed and the contents poured out to form a flat slab about ½-inch thick. In this condition the zinc can be added easily to the brass. Both the lead and tin pipe can be used more advantageously when remelted in this way. Use sal-ammoniac as a flux for the zinc and rosin for the tin and lead.

However, it is poor policy, in a manual training school to use such materials, since the results are not in accord with good, commercial brass foundry practice. Therefore, it is more advisable not to attempt to teach the students at all than to teach them wrong methods. It is impossible to make good alloys from wash boiler bottoms even when the greatest care is exercised in manipulation and the results are misleading on account of the impurities that are introduced by such material. Bronze particularly is susceptable to impurities. The character of an alloy of copper and tin is greatly changed by the addition of 0.10 per cent of iron. Attempts to prevent oxidation while melting such scrap copper as wash boiler bottoms is like locking the stable door after the horse has been stolen, because the material itself is oxidized and encrusted with dirt. The melting losses from the use of such junk are immensely greater than from clean copper clippings and similar material and these go a long way in offsetting any monetary gain due to the lower prices at which such materials can be purchased.

Porous Brass and Bronze Sticks

We are experiencing difficulty from porosity in making brass and bronze sticks. The metal is melted in coke-fired pit furnaces and the several mixtures which we have employed have given poor results. How can we overcome this trouble?

The following mixture will give good results: Copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent, and lead, 5 per cent. The copper should be kept covered with charcoal while melting and add a small amount of salt when the metal is just molten, stirring thoroughly, after which the white metals are added and cast at a medium temperature. To secure sound castings, place a riser at the end larger in diameter than the stick, with generous connections to the casting. This will allow the eutectic, when the casting is solidifying, to drain down and fill the spaces between the crystals which already have formed. Microscopic examinations of alloys indicate that small runners and risers are a fruitful source of losses in making bronze castings, as the latter may appear sound to the uninitiated when in reality they are exceedingly porous and are permeable to liquids and gases under pressure.

Zinc Alloy for Match-Plates

We have been making match-plates from aluminum, which is exceedingly expensive at the present time, and we have been wondering whether there are other mixtures which we can employ that are more economical.

Since all metals are more than ordinarily expensive at the present time, it is doubtful whether, weight for weight, aluminum is not as economical to use as anything that could be substituted therefor. An alloy of zinc possibly might be employed in place of the aluminum. This mixture follows: Zinc, 72 per cent; tin, 20 per cent; copper, 5 per cent; lead, 2 per cent, and aluminum, 1 per cent.

Pitted Brass Plungers

I am having trouble with a brass plunger, 10 inches in diameter and 4 feet long. The castings are badly pitted. My mixture consists of 54 pounds of Lake copper, 5.5 pounds tin, 8 pounds lead, 6 pounds zinc and 46.5 pounds red brass scrap. This mixture is melted in an oil furnace. The castings are poured on end and are gated at the bottom with risers at the top. Can you advise me what is causing the pitting?

If an analysis of the red brass scrap indicates that it contains neither lead nor zinc and merely copper and tin, the mixture outlined might be used. However, it can be safely assumed that the scrap has been well-leaded and zinced by its maker and it can be relied upon to carry all of these metals into the alloy. Therefore it is inviting disaster to make further additions of these metals. If it is absolutely essential that a cheap metal be employed in these plungers, we suggest that the zinc be eliminated entirely, as well as 6 pounds of the lead, and if it is necessary to keep the mixture at 120 pounds, the tin should be increased to 7 pounds and the copper to 64.5 pounds.

The following alloy, however, would serve your purpose much better than the one given: Copper, 88 per cent; tin, 8 per cent; zinc, 2 per cent, and lead, 2 per cent.

Mixture for Aluminum Pistons

Recently a mixture for aluminum pistons was published in the columns of The Foundry and it was stated that complete fusion and amalgamation is effected by the addition of aluminum to form a hardener, which subsequently is melted in the proper percentage of aluminum to obtain an alloy of the proportions recommended. We would like to know what percentage of the 95.75 per cent is used to constitute the addition of aluminum and we want to know whether the remaining per cent of 95.75 per cent is the proper percentage. At what time in the operations is the 0.75 per cent of tin added and when is 0.25 per cent of magnesium incorporated in the bath? Also let us know what temperature the alloy will stand. It is our intention to obtain the specific procedure in order to ascertain when the various ingredients are added and a suitable division of the aluminum.

While the alloy referred to can be made without difficulty by a skilled metallurgist, it is realized that the results might not be so gratifying when it is handled by anyone who has not made a study of the synthesis of aluminum alloys. Accordingly, the following is recommended to take the place of the one which is made with greater difficulty: Aluminum, 94 per cent and copper, 6 per cent. To make this alloy, melt 25 pounds of copper under charcoal, add 25 pounds of aluminum in small pieces, a little at a time, stir the mixture thoroughly and cast into ingots. To make the alloy, place in the crucible 12 pounds of the copper-aluminum alloy and add thereto 88 pounds of pure aluminum. Do not allow the metal to become hotter than a dull red. Stir well, add a small amount of zinc chloride and pour when just cooled to a silver color.

An Unusually Strong Manganese Bronze

I would like to get a good mixture for manganese bronze that will develop a tensile strength of 60,000 pounds per square inch with an elongation of 20 per cent or more. The test bars are to be cast in sand. I have cast several test bars and the highest tensile strength was 50,000 pounds per square inch and some were as low as 40,000 pounds per square inch.

The following alloy will meet the specifications outlined: Copper, 56 pounds; zinc, 40.5 pounds; iron, 1.5 pounds; tin 1 pound; 80 per cent ferro-manganese, 0.5 pound and aluminum, 0.5 pound. Reduce the ferro-manganese to pea size, place it in the bottom of a crucible with the iron, which should be in the form of thin strips of tin plate, charge the copper on top, add charcoal and salt and melt in a clean, hot fire. Stir the mixture thoroughly and when molten, add the aluminum, then the zinc, to be followed by the tin. Stir again, pour into ingots and remelt the ingots for the castings. The physical properties of this alloy were as follows: Average of two test bars; ultimate strength, 83,000 pounds per square inch; elastic limit, 42,800 pounds per square inch; elongation, 21.3 per cent in 2 inches and reduction of area, 22.1 per cent.

Powdered Coal as a Fuel in Malleable Shops--IV

The Application of This Ground Material to Annealing Ovens is Discussed and a Type of Redesigned Furnace is Described

By Joseph Harrington

THE annealing process differs widely from the practice of melting. In the latter case the quick application of a high temperature is desired, whereas in the former, a prolonged maintenance of a moderate temperature is necessary. The problems of supplying heat under these two conditions, therefore, are quite distinct, and consideration must be given to whatever means are at hand for high combustion efficiency at an absolutely constant rating. When using natural gas in the annealing oven, the conditions surrounding the operation are almost ideal. Perfect cleanliness prevails and constant conditions can be maintained without much attention or manual labor. Inasmuch as the annealing of iron is the gradual removal of the carbon element, from a state of solution, a process which involves considerable time for its completion, it is essential that the temperature be maintained constant to avoid disturbances in the process of carbon separation.

The application of powdered coal to this service may be properly compared to the use of gas, inasmuch as the fuel is of gaseous consistency, and is introduced in a continuous stream from a fan through nozzles or orifices. It is desired, of course, to bring the oven to annealing temperature as rapidly as possible, because the separation of the carbon does not begin until this temperature has been reached, and any loss of time between closing the oven and the attaining of this temperature reduces the output of a given oven to that extent. When starting an oven with powdered coal, it is desirable to introduce the fuel at a rate at least twice as fast as that which obtains during the prolongation of the heat. This is readily accomplished by the control of the feeding apparatus.

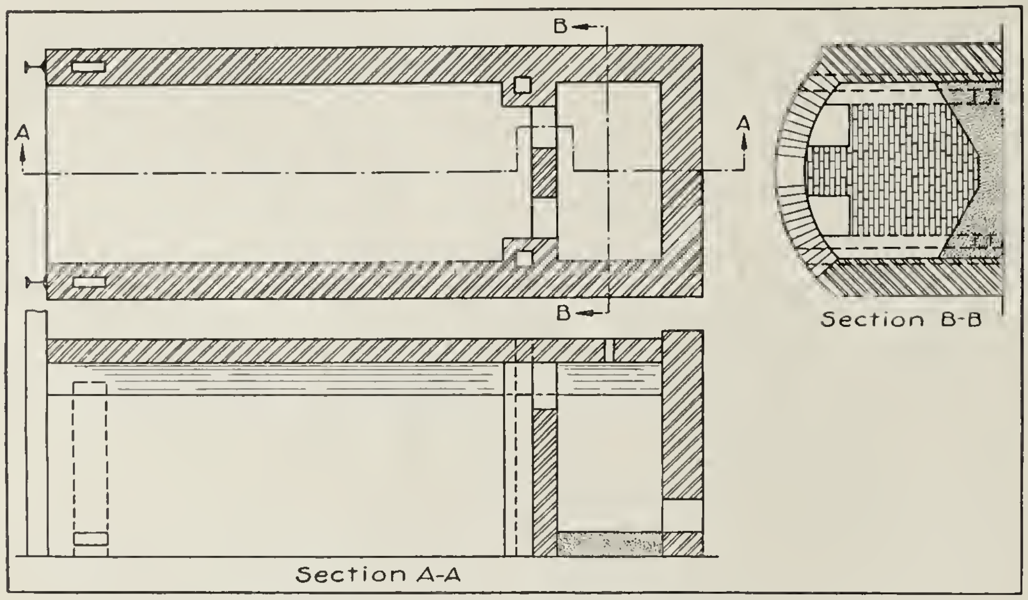


FIG. 1—IMPROVED TYPE OF MALLEABLE ANNEALING OVEN WITH SEPARATE COMBUSTION CHAMBER

There are two general types of ovens which should be considered in this discussion. The first and least common is the muffle type, wherein the products of combustion do not come into direct contact with the metal being annealed. Under these conditions it is not necessary to pack the iron in pots, but it may be piled in bulk within the muffle. The muffle being closed, the exclusion of air is accomplished and oxidation of the product is avoided. The furnace used in connection with this type of annealing oven can be of any type desired. With powdered coal, as in other applications of this kind, the fuel is injected into a combustion chamber of considerable size, which entirely or largely surrounds the muffle. The efficiency of the process is not as great as in the other case, but there are advantages when certain classes of castings are being produced.

The other and more common type of annealing oven is merely a chamber wherein the metal is placed, being contained in pots made of cast iron and packed with mill scale or other substance. Without exception, the powdered coal has been injected directly into the furnace above the pots. The roof preferably is raised at that end, to allow room for the expansion and combustion of the gases near the nozzles. In all cases, the powdered coal flame is introduced horizontally, and the dust resulting from the combustion of the coal settles over the pots and upon the floor. With the exception of a local area close to the jets, the temperature is below that of the fusing point of ash. Consequently, almost any coal can be used, although coal containing a high percentage of sulphur is undesirable, on account of the injury to the pots resulting from the sulphur gas. The most objectionable feature, when using a high ash coal for this purpose, is in the actual volume of ash deposit. It has been found, however, that any coal not too heavily burdened with ash is satisfactory for this purpose, and the amount resulting from the coal required to keep the furnace up to temperature is not so great as to seriously interfere with the efficiency.

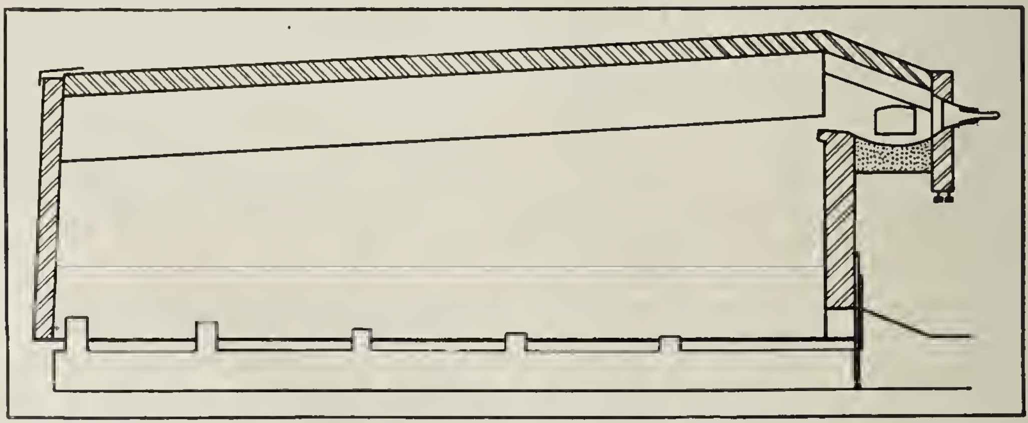


FIG. 2—SECTIONAL VIEW OF OLD STYLE OF MALLEABLE ANNEALING FURNACE

The ash dust is swept out after each firing. There is no doubt, however, but that the dust is undesirable. So far as I know, it has no effect on the pots or floor, but has a high insulating value, and must have a certain effect on the amount of heat absorbed by the pots. In addition to this disadvantage, the removal of the ash is a rather dirty process. Fig. 1 shows the plans of a furnace in which it is believed the ash dust evil can be eliminated. It is the first type of its kind, and is now being built at the plant of the Pittsburgh Malleable Iron Co., Pittsburgh, where 30 ovens are being remodeled. The oven was not disturbed, but the rear wall was moved back several feet. Two ports of considerable size are left in the partition wall at the back of the furnace. The burner or jet is placed directly in the center and points downwardly in a vertical direction. The velocity of the gas from the burner is not great enough to carry the flame to the bottom of the combustion chamber, but it is sufficient to cause the dust and gas therefrom to pass below the line of the ports. The upward sweep of the gases has a separating effect on any solid matter which may be in suspension. This is particularly true of any liquified particles which are very much heavier than the gases and separate readily. The dust, therefore, is thrown out and accumulates in the bottom of this space, from which it can be removed readily. Clear gases only enter the ports at a low velocity and spread out evenly over the entire oven.

Heat Distribution

At each of the four corners there is a vent connecting with the chimney. Each vent has an adjustable damper, so that the distribution of heat is under perfect control. This design obviates injury to the pots due to the direct impingment of the flame, and to the consequent high temperature which is encountered directly at the nozzle. The heat is diffused and modified by the time it enters the annealing chamber, and with the relatively small amount of coal burned, the separation of the ash content is not a difficult matter. Another advantage of this design is in the increased temperature of the combustion chamber as compared with that of the oven. The combustion chamber is of sufficient size to hold the gases for a considerable period. The reversal of direction also has a definite mixing effect, with the result that the excess air can be reduced to the minimum.

This oven has not been tried out, but I have no reason to doubt my ability to obtain and maintain 17 per cent of CO_2. I also show, for comparative purposes, a design of the standard oven, Fig. 2, which, so far as I am aware, is the only design now in use. In order that the nearest pots should not be burned, it is desirable, if not necessary, to have the roof raised at the firing end. This is for the purpose of giving a little expansion space to the gases, and to modify the local temperatures. The type of oven shown in Fig. 1 will be in service by the time this article appears and an effort will be made to present a report of the results of its operation in the February issue of *The Foundry*.

Influence of Design on the Cost of Patterns

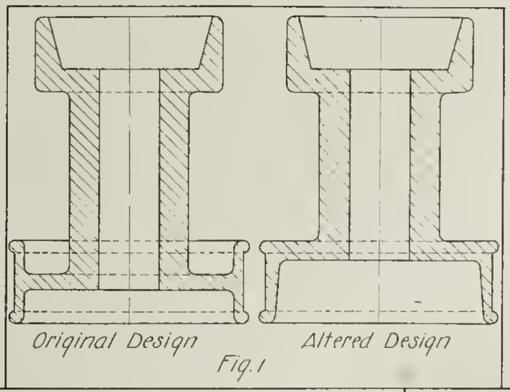
By John Leafstrom

IN DESIGNING machinery and mechanical equipment constructional economy is essential if the product is to be commercially practicable. For this reason, considerable thought is given to the correct methods of machining the parts, the ease of assembling, the materials used and other phases of machine construction. The question of making the patterns, however, is not always given the attention and thought that its importance warrants. Since, however, the cost of a machine or mechanical device is influenced by the cost of making the patterns, the proper design of the parts, with a view to pattern simplicity, should be given careful consideration.

The relation of the pattern cost to the total cost of mechanical equipment falls roughly into three classes, as follows:

1—Making jigs, fixtures, special attachments for machinery, and equipment of similar character. In this class of work, the pattern cost forms a large percentage of the total cost, as the cost of making a pattern is usually greater than the cost of machining a part and this class of work requires only a few parts of a certain kind.

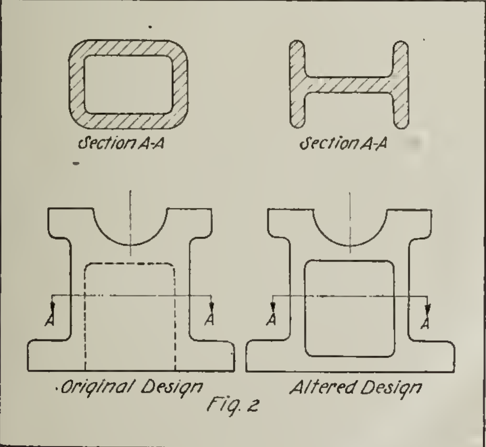
2—Making special machinery and similar equipment having a limited demand. In this class of work, the importance of the pattern cost is less than in the type of work in class 1 because the expense of making the patterns is divided into a greater number of parts.

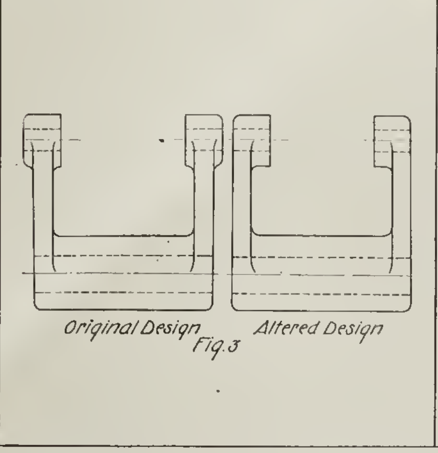


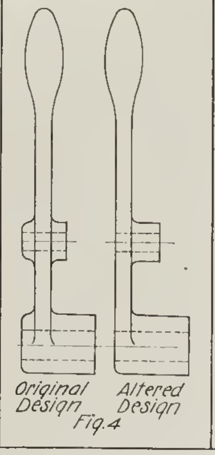
3—Building standard machinery and mechanical equipment made in large quantities. In this class of work, the pattern expense is least important as the cost is distributed over a great number of parts.

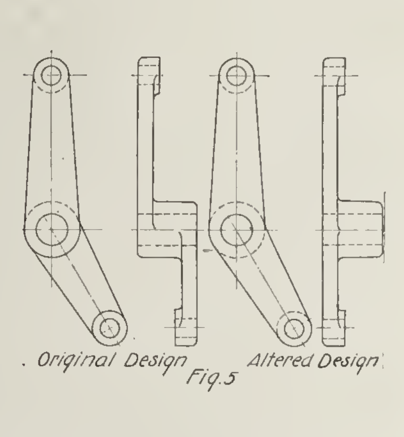
In all cases, of course, it is desirable that the pattern cost be low, in order to keep down the initial investment and thus reduce its effect on the consequent overhead.

When making drawings of parts for the pattern shop the refinement and amount of work called for should be consistent with the number of castings needed. It is obvious that a pattern for a *one casting* job should be as simple as the purpose of the casting permits. On this class of work, it is often more economical to allow unnecessary metal at some parts of the casting than to make cores for









HOW THE PATTERNS WERE IMPROVED BY SLIGHT ALTERATIONS producing a lighter casting. Similarly, it is more economical to drill out a few bolt holes in a casting than to core out the holes.

After receiving the prints of the details, the patternmaker may note certain features of the parts that if altered, would simplify the pattern. However, it is not always possible to consult the designer and in such cases the details are generally made as laid out. In cases of this kind, the designer will find it an excellent plan to send, with the pattern details, a print of the assembly. This will enable the patternmaker to determine if any change he desires will cause interference or is in conformity with the plan of construction that previously has been proposed.

The accompanying illustrations, taken from the writer's experience and observation, show several examples of alterations in machine details that were made to reduce the pattern expense. Fig. 1 shows a small pulley and clutch casting. The original detail requires a three-part flask pattern. Altering the detail, as shown, permits the use of a plain pattern. Fig. 2 illustrates a small bearing bracket. The original design requires a core box to be made. By making the detail, as shown in the alteration, the pattern is reduced to a single piece. Fig. 3 shows a clutch yoke. The original detail shows the conventional method of making this type of casting. Making the detail, as shown in the alteration, eliminates the necessity of putting bosses on the outside of the yoke. Fig. 4 illustrates a lever handle for a machine. The same kind of advantageous change can be made, as in Fig. 3. Fig. 5 shows a common bell crank. The original detail requires a built-up pattern, each arm of the crank being cut out separately from the wood and built-up with the bosses to suit. By altering the detail as shown, the crank can be cut out complete from one piece of wood and the bosses added on one side.

These illustrations show the examples of details of various types where the design was simplified with a view of pattern economy. In each case, the function of the part was not affected or limited by the change that was made.

How Zinc-Coated Parts are Tested

By E P Later

METAL parts are plated or coated with some other metal for the purpose of improving the appearance or affording protection from destructive agencies, such as corrosion or rust. In the case of iron, the finish generally is regarded from the protective standpoint primarily, with the decorative effect produced thereby ranking second; with much of it, however, the latter feature is not considered and whatever finishing processes the iron parts are subjected to are strictly for the purpose of preventing rust and it is this phase of the question that will be discussed in this article.

Metals such as copper, nickel, lead and others may be used to produce the necessary coating, but those involving the use of zinc in some manner are by far the most important. Zinc is preferred for a number of reasons, the most important of which is its comparative cheapness, at least until recently, and the fact that it is peculiarly suited to this work, since it is the most electro-positive to iron of all the metals which can be used practically.

Why Tests Are Essential

Whatever metal is employed, however, it is apparent that some means of quickly and accurately determining the weight or thickness of the coating produced should be known, in order that both manufacturer and consumer may be assured that it is sufficient to give the protection desired; such a test is of value to the producer in that it obviates the possibility of loss through the application of much heavier deposits than are actually required, and at the present price of zinc this is a factor not to be too lightly regarded. Most zinc coated material now is purchased on specifications which provide that it bear a certain minimum weight of metal per unit area. Therefore, a consideration of the various methods of testing such parts may be of help to those who are called upon to produce or handle them in one way or another.

Methods of Applying Zinc

Unlike most metals, zinc may be applied to iron objects by the following three widely varying ways: By dipping them into the molten metal; by depositing zinc electrolytically from a plating bath and by the vapor or Sherardizing process. All of these methods are widely used and each has advantages which may especially commend it in certain cases and while the plater may be more interested in the cold galvanizing process a short description of the others may not be amiss.

In the hot or dip method, the parts are cleaned by pickling, generally dipped in some acid flux and then immersed in a bath of molten zinc. In addition, sal-ammoniac or some other fluxing agent is used to insure the clean surface requisite for the perfect adherence of the coating. After the parts have become thoroughly heated and covered with the zinc they are withdrawn and the excess of metal shaken or wiped off, depending on their shape.

Only within comparatively recent years has it been possible to obtain a good deposit of zinc electrolytically, on a commercial scale. A great deal of work has been done along these lines, however, so that very fair coatings can now be produced, although further advances will no doubt be made.

For any readers who may not be familiar with the process it may be said that it consists in immersing the carefully cleaned and pickled parts in a solution composed essentially of zinc sulphate, with a very slight amount of free sulphuric acid. Various organic substances also are added to assist in the production of a smooth, dense deposit. There is a large number of formulae for these baths, many of which are patented or secret. The plating time varies from 20 minutes to an hour or more depending on the current density, the weight of deposit required and so on.

It may be noted, also, that the coating produced by these different processes varies considerably in several respects. For instance, in the hot dip method the zinc is spread over the surface, possibly with the formation of a small amount of zinc-iron alloy. This coating is relatively impure, containing a large percentage of iron and lesser amounts of several other metals.

The Plated Coating

The coating which is produced by the plating process is of great purity ordinarily, and when properly carried out a very smooth, uniform deposit is applied. This method is applicable in many cases, as with small parts, where the hot dip method would clog up small holes or threads and prove generally unsatisfactory. It also possesses the great advantage of very easy control, allowing a coating of definite weight to be produced at will.

On the other hand, however, the deposit is more or less porous, depending somewhat on the conditions under which it is made.

The Sherardized coating differs markedly in some ways from that given by either of the foregoing processes. It was developed by Sherard Cowper-Coles, although some of the fundamental facts regarding it have been known for a long time. In this process the thoroughly cleaned parts are placed in an iron drum with a quantity of finely powdered zinc, which contains a considerable, although varying, amount of zinc oxide. This drum is then put into a gas-fired or electrically-heated furnace and brought to a temperature of about 800 degrees Fahr., which is maintained for a period of time the length of which depends on the thickness of coating desired. A furnace will turn out two or three charges per day, according to conditions. When the drums are sufficiently cool they are emptied over a grid or screen so that the zinc dust falls through and collects in bins, to be used again.

One great advantage of this process is that the zinc coating is applied very evenly and uniformly over all surfaces accessible to the powder, so in this respect it is superior to the methods previously considered, especially the electrolytic, with which difficulty is experienced in getting the zinc to deposit in inner corners and recesses.

Alloying with the Iron

The size of the parts is increased very slightly by this treatment, showing that a coating is applied, but perhaps the main action is one of alloying with the iron rather than depositing zinc on the surface. It has been shown that a polished and etched specimen of Sherardized iron presents a relatively complex structure. The zinc penetrates the iron with the formation, in particular, of deep layers of two alloys of zinc and iron, one of these being richer in iron than the other, together with a number of more or less unknown alloys containing varying amounts of the two metals. Upon the surface there is generally a layer of relatively pure zinc, although frequently the process is carried to the point where only a deep layer of alloys is formed. When examined under a microscope this alloy is seen to be covered with fine cracks or fissures, as though it had contracted in cooling.

It probably will be appreciated that these variations in structure and composition will affect, to some degree, the behavior of the coating under some of the tests which are applied to determine its quality and character and this fact should be kept constantly in mind when making such tests.

Coming to the methods employed for this purpose, there are two which find considerable use as a rough and ready means of finding out something about the weight of the coating and of these, what is known as the Preece test is the older and perhaps better known, as a good deal of material is purchased under specifications based on this test.

Preece Test

In principle it depends on the fact that zinc, when dipped into a strong solution of a copper salt, is dissolved and takes the place of the copper, which appears in metallic form. Iron does the same thing as the zinc, but much more slowly, so that the copper deposit formed on the zinc is very coarse and easily removed while that on the iron is more or less hard and bright. Putting these together, when a zinc coated piece is dipped in a copper sulphate solution, the copper first deposited is easily wiped off, but as soon as the zinc is all gone the copper plates out on the iron, this point being determined by the difference in appearance and behavior of the coating. Practically, it is sometimes a little difficult to tell just when all of the zinc is removed; also, there are several factors which may work to impair the value of the results obtained, so exact directions have been compiled covering the application of the test and the means by which the critical point may be recognized. Thus, there is, ordinarily, a good degree of uniformity in the manner of using it.

To make the test the copper solution is prepared by dissolving sufficient crystals of copper sulphate, bluestone or blue vitriol, in warm water to form a saturated solution, excess of black copper oxide is added and the solution filtered, cooled to a temperature of 65 degrees Fahr., and diluted to a specific gravity of 1.186.

The samples to be tested should be thoroughly cleaned of all grease and dirt and the temperature of the solution must not be lower than 65 degrees Fahr. nor more than 70 degrees Fahr. The parts are immersed in the fresh solution for exactly one minute. They are then taken out, rinsed in water and wiped with clean cotton waste or a rag, after which they are immersed again for exactly one minute, washed and dried. If the material is required to stand more than two dips the process is repeated the requisite number of times, then the parts are examined to see if there are any traces of a bright copper deposit. With a little practice it becomes easy to distinguish between the true and false copper deposits which are sometimes formed, and to aid in doing this it is advisable to immerse one of the same kind of parts as are under test in dilute hydrochloric acid until all the zinc coating is removed, then wash and dry and dip in the copper solution. The color and character of the copper deposit formed can then be taken as a guide in examining the other parts.

As a suggestion, a good, hot galvanized coating should, and generally is, required to withstand four dips, although it may withstand more or less, according to the conditions of service to be met. This is also true of the electro-galvanized and Sherardized coatings.

To obtain good results requires careful attention to details; the solution must be properly made up and standardized; a fairly liberal quantity of solution should be used for each test and the same portion should not be used for testing more than one part. Sherardized parts are treated in all respects exactly like hot-dipped or electro-galvanized, with the exception that after each immersion they should be scrubbed with a stiff, bristle brush instead of wiped with a rag, as the false deposits seem to be harder to remove.

Objections to the Test

As a whole, this test has been objected to for the reason that it assumes that the zinc is removed in direct proportion to the time of immersion, and that this really determines the thickness of the coat at its thinnest part. When applied to electro-galvanized or hot-dipped work, it is a fairly satisfactory means of indicating the thickness and uniformity of the coating and meets commercial requirements of speed and reliability. When applied to Sherardized material, however, it is the opinion of several investigators that very misleading results may be obtained, at least unless it is used carefully. The trouble apparently is that some of the zinc-iron alloys are indicated as iron, while in reality they have very good protective powers.

It may be noted, however, that with a Sherardized specimen the portion of the coating next to the iron shows a lighter color during this test than that nearer the surface. For this reason then, when a light area shows up on a darker background, after the brushing and drying, it indicates that the coating is thin and failure may be expected at this point. Sometimes, perhaps due to imperfect brushing, copper will form on the surface of the zinc, but it can generally be distinguished from the copper deposited on the iron from the true breakdown, in several ways. The latter is lighter in color than the other, is surrounded by an area of lighter colored coating and tends to form in the hollow places or deeper parts while the real deposit is found on the top or more exposed portion.

Lead Acetate Method

In order to eliminate some of the disadvantages inherent in this test, another method known as the lead acetate has been worked out and is finding a considerable field of usefulness. In principle it resembles the Preece method and consists in immersing the zinc coated parts in a solution of lead acetate, whereupon the zinc and lead exchange places, the former going into solution and the lead plating out as a metallic deposit. This usually can be brushed off easily and, if desired, saved and weighed or otherwise estimated and from the data thus obtained the weight of the galvanized coating can be calculated. Simpler still, the iron specimen may be weighed before and after stripping the zinc coating in the solution and the difference in the two weights will represent the weight of zinc removed, from which the weight per unit area may be obtained.

The solution is made by dissolving 400 grams of crystallized lead acetate in a little less than a liter, somewhat more than a quart, of water, adding 4 grams of litharge, an oxide of lead, and shaking. After allowing suspended matter to settle the clear solution should be poured off and diluted to a specific gravity of 1.275 at 60 degrees Fahr.

Conducting a Test

In conducting a test, the specimen is carefully cleaned and completely immersed in the solution—the usual length of time for a dip being three minutes—then removed, washed, the spongy lead removed with the fingers or a brush and the sample examined to see if the coating has broken down. If not, the part is again immersed. Three or four dips usually are sufficient to remove at least the greater part of the zinc.

The difference in appearance of the spongy lead and underlying iron is great enough to allow them to be distinguished, but under some conditions dense, coherent lead forms and renders it much harder to decide when all of the coating is gone.

It will be noted that when this test is carried only to the point where the iron shows through in one or two places, it has merely indicated the thinnest spot and gives little information about the average weight or thickness of the deposit, to this extent resembling the copper sulphate test.

By carefully cleaning and weighing the specimen, then immersing in the lead solution until the zinc is entirely removed, finally brushing off the spongy lead, drying and weighing again, the actual weight of zinc is obtained; dividing this by the area of the part and moving the decimal point three places to the right expresses the result as milligrams per square inch. Thus, a certain part having an area of 3.6 square inches lost 0.1886 gram by immersion in lead acetate, then $0.1886 \div 3.6 = 0.0524$, or moving the decimal point, 52.4 milligrams per square inch.

For some purposes a knowledge of the amount of iron in the coating may be helpful and in such a case the iron may be determined by reducing the lead solution in which the coating has been stripped off with zinc dust and titrating with standard permanganate of potash solution; or the lead may be precipitated by sulphuric acid and the iron thrown down by ammonia, filtered off, ignited and weighed as ferric oxide.

Lead Acetate for Sherardized Parts

In applying the lead acetate test to Sherardized parts considerable trouble has been encountered through the formation of the dense, coherent lead deposits previously referred to, which interfere greatly with the action of the solution on the underlying zinc; this may be overcome largely or entirely by dipping the samples in 20 per cent acetic acid, or very dilute hydrochloric acid, 10 per cent, for a few seconds or until gas bubbles begin to come off.

Both the Preece and lead acetate methods involve the preparation of standard solutions and the former will, at most, locate the thin spots without telling anything about the weight on the rest of the surface. For anyone who has access to a good balance one of the simplest ways of determining the weight of the coating is to clean and weigh a small piece of the coated part and then boil it in caustic soda or potash until the zinc is all removed; the iron is not appreciably attacked by this treatment. At the end of several hours the part is removed, washed and dried carefully and weighed again. Subtracting this weight from the former one gives the weight of zinc present and, as before, dividing this by the area of the part in square inches and moving the decimal point three places to the right expresses the result as milligrams per square inch, from which data the ounces of zinc per square foot may be calculated easily if desired.

Often it is not necessary that the zinc coating be determined with a high degree of exactness, as a couple or so of milligrams one way or the other will not make much difference in most classes of work. In such a case use may be made of a method which has been rather recently developed, with a decided gain in the length of time required to make the test and very little sacrifice in accuracy.

A Recently Developed Method

It involves immersion of the part in hydrochloric acid containing a certain amount of chloride of antimony. In practice, the metal parts are cleaned, dried and weighed, then immersed in the acid for one minute, which is long enough to dissolve all of the zinc in the coating, while the amount of iron removed is almost negligible. At first the presence of the antimony salt seems to hasten the solution of the coating, then when this is gone, a thin film of metallic antimony plates out on the iron or steel and protects it from the action of the acid.

The acid solution is prepared by dissolving 2 grams of antimony trioxide in 100 cubic centimeters of concentrated hydrochloric acid, and adding 5 cubic centimeters of this to 100 of strong acid, after which it is ready for use. The same quantity of acid may be used for several samples, but 5 cubic centimeters of the antimony chloride solution should be added after each test, in order to make up for the antimony which is removed from solution through plating-out on the iron.

The difference in the weight of the part before and after stripping represents the weight of zinc in the coating and the amount per unit area may be determined as previously noted.

Officers for the ensuing year were renominated at the meeting of the Philadelphia Foundrymen's Association held at the Manufacturers' club in that city, Dec. 6. The nominations are as follows: President, Thomas Devlin, Thomas Devlin Mfg. Co., Philadelphia; vice president, George C. Davies; treasurer, Josiah Thompson; secretary, Howard Evans, and executive committee, Walter Wood, Thomas M. Eynon, H. L. Haldeman, Walter T. Macdonald and W. S. Dunning, of Chester.

Chill Molds for Casting Non-Ferrous Metals

(*Continued from page 29.*)

hole and act as a stopper. This crucible was heated to redness and placed in a position over the gate of the mold. Molten metal was poured into the hot crucible, and when it was reasonably certain that all the dross had risen to the surface, the stopper was removed and the clean metal from the bottom was allowed to teem into the mold. By this means the castings were quite free from surface imperfections. A comparison of the mechanical properties of chill castings and sand castings may be drawn from the data in the accompanying table.

Pattern Design from the Foundryman's Viewpoint

By M. E. Duggan

When designing machine parts ,a simple detail often will complicate the making of the pattern, thereby increasing the labor, pattern shop expense, as well as the cost of producing the casting. It is true that it is not always possible to so design these details that they will meet the requirements of the patternmaker and the molder, but the patternmaker, if he has a knowledge of molding, can plan his pattern so that it will consist of the smallest possible number of parts, and in such a way that it can be molded easily in the foundry.

The accompanying illustration shows a sketch of a damper. In Fig. 2 the bosses, *A, B, C* and *D,* constitute the smallest part of the pattern and the design is so simple that the making of the model requires very little planning by the patternmaker. Five methods of making and molding this pattern are indicated at *E, F, G, H* and *K.* Any of these methods might be termed practical, but an investigation of methods *E, F* and *K* will quickly convince one that they require extra time, labor and material in the pattern shop and involve molding difficulties in the foundry. Method *E* involves the use of four cores, the bosses being molded in green sand. By method *F* two cores only are required, which are attached to the inside of the pattern, bosses *B* and *C* being made in the core and bosses *A* and *D* are made loose on the pattern, to be drawn in and up through the mold after the pattern is removed. Both of these methods are objectionable because they increase the work of the molder and require accurate setting and matching of the core in the mold to avoid disfiguring the four surfaces of the casting.

Method *K* involves splitting the pattern through the center on the line *XX,* the entire pattern being molded in green sand with the exception of the circular pocket *K,* which is made by a core. This method likewise is impractical, since it involves a large amount of unnecessary labor in the construction of the pattern and is contrary to good molding practice. The core *K* is heavy and the surface on which it rests in the drag is too small to support it satisfactorily. It must be secured to the mold by wires to prevent it from shifting in the mold. While this method has nothing in its favor, nevertheless it is surprising to note the number of patterns that are molded in this way. Method *H* is simple and practical for both the patternmaker and the molder. Four prints are required for the bosses, which are made loose on the pattern. Sand is filled in to the top of the prints and after ramming, the prints are removed and in their places four cores are set, which contain impressions the same shape and dimensions as the bosses. In other words, these cores mold the bosses. After the four cores are set, the filling-in and ramming of the sand is continued and the drag half of the mold is completed. The drag then is rolled over to receive the cope and when the mold is finished, the cope is lifted and the pattern is drawn from the drag. To the patternmaker who is inexperienced in foundry practice this method might not be very clear. However, do not make the same mistake as that of a fellow workman who made four bosses and four core prints. In each print he turned a recess to receive and fit over the bosses, which he pinned loose to the pattern.

Another method will be described for making this pattern and molding it in the foundry. This is similar to method *H,* with the exception that the pattern has four loose core prints, but no bosses, while by method *G* the pattern has four loose bosses, but no core prints. The core, *G,* shown in the dotted lines, Figs. 1 and 2, is a block made with a half circle that fits over the circumference of the bosses down to the center line, no prints being necessary. The cores answer the double purpose of print and core, the pattern being molded in the drag in the position as shown by Fig. 2. The two cores are placed on the pattern as indicated by *G.* Sand is filled to the top of the core and before adding additional sand, the two cores are lifted from the mold and the bosses *A, B, C* and *D* are withdrawn. The cores then are placed back in the mold and the ramming of the sand is continued, and when the drag is finished, it is rolled over ready for the ramming of the cope.

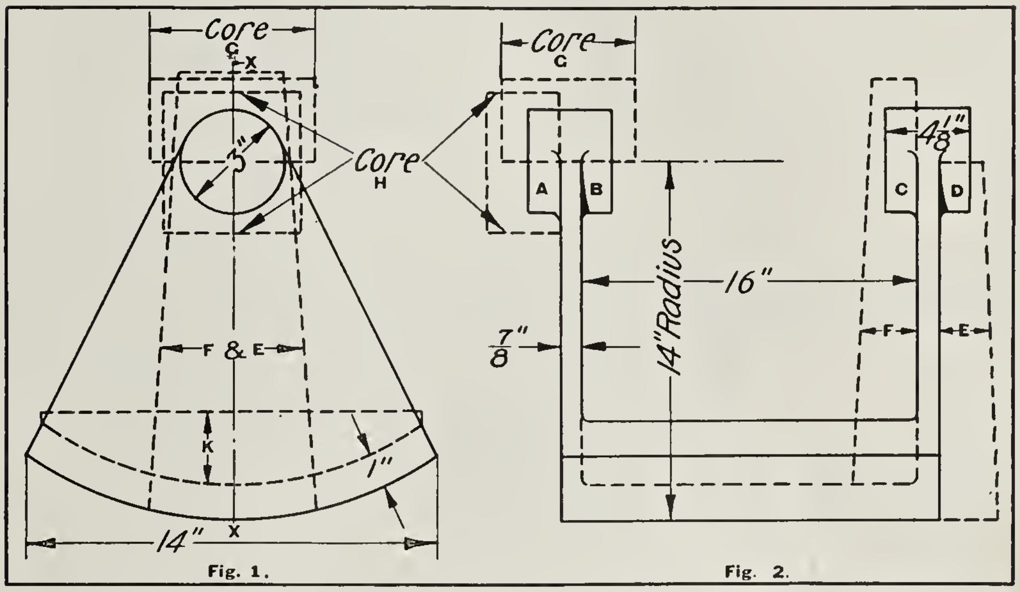


Fig. 1. Fig. 2.

VARIOUS METHODS OF MAKING A SIMPLE PATTERN TO MEET THE REQUIREMENTS OF THE FOUNDRY ARE SHOWN IN FIGS. 1 AND 2

Increased Use of Molding Machines in English Foundries

At a meeting of the Sheffield, Eng., branch of the British Foundrymen's Association, held on Nov. 17, attention was directed to the increased use of molding machines in English casting plants after the conclusion of the war. At a previous meeting of the Sheffield branch the following resolution was adopted: "As the foundry trade will have to be prepared for the period after the war, when it will be necessary to reduce the cost of production to compensate for increased wages, etc., it is essential that the subject of the application of molding machines should be fully discussed throughout the country and with this object in view, the various branches of our association should endeavor to secure the services of lecturers who are competent to discuss the subject from an impartial standpoint. It is hoped that the parent association will give every encouragement for the discussion of this topic and we feel that it is to the best interests of all concerned that this course be pursued."

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Contents

MAKING NON-FERROUS CASTINGS IN A RAILROAD SHOP.............. 1
SHRINKAGE AND CONTRACTION.............................. 5
HOW PROFIT-SHARING HAS WORKED IN FOUNDRIES................. 6
IMPROVED SANDING ROLL FOR THE PATTERNMAKER'S LATHE.......... 8
A COST SYSTEM FOR A SMALL MALLEABLE FOUNDRY................ 9
MIXTURE FOR BRONZE PARTS.................................. 13
CONSTRUCTING A SIMPLE PATTERN............................. 13
ALL IRON IS GOOD IRON..................................... 14
CAST IRON BALLS FOR GRINDING MILLS........................ 14
HEAT-RESISTING GRAY IRON.................................. 14
HOW TO USE TITANIUM IN MAKING STEEL CASTINGS.............. 15
SHRINKAGE OF MALLEABLE CAST IRON.......................... 19
CASTING IRON AROUND A RIGID CENTER........................ 20
A TIME-SAVING STAND FOR CHECKING MELTING LOSSES IN A BRASS FOUNDRY 20
POND TRUSS FOR BUILDINGS.................................. 20
ALUMINUM BRONZE TESTS AND THEIR SIGNIFICANCE.............. 21
CHILL MOLDS FOR CASTING NON-FERROUS METALS................ 28
POROUS BRASS CASTINGS..................................... 29
MELTING DOWN SCRAP.. 29
CLEANING SOLUTION FOR BRASS CASTINGS...................... 30
DIFFICULTIES IN MAKING BRAZING BRASS...................... 30
AEROPLANE METAL 30
DIFFICULTIES DUE TO INSUFFICIENT FEEDING.................. 30
TRYING TO USE PURE SCRAP.................................. 30
POROUS BRASS AND BRONZE STICKS............................ 31
ZINC ALLOY FOR MATCH-PLATES............................... 31
PITTED BRASS PLUNGERS..................................... 31
MIXTURE FOR ALUMINUM PISTONS.............................. 31
AN UNUSUALLY STRONG MANGANESE BRONZE...................... 31
POWDERED COAL AS A FUEL IN MALLEABLE SHOPS—IV............. 32
INFLUENCE OF DESIGN ON THE COST OF PATTERNS............... 33
HOW ZINC-COATED PARTS ARE TESTED.......................... 34
PATTERN DESIGN FROM THE FOUNDRYMAN'S VIEWPOINT............ 37
INCREASED USE OF MOLDING MACHINES IN ENGLISH FOUNDRIES..... 37
PROSPECT AND RETROSPECT................................... 38
COMBINATION ELECTRIC JAR-RAMMING AND POWER ROCK-OVER MOLDING MACHINE 39
DEMONSTRATING THE RELIABILITY OF MOTOR DRIVE.............. 40
DEATH OF T. L. GRIFFITH................................... 40
CASTING MALLEABLE IRON IN PERMANENT MOLDS................. 40
PERSONAL 41
GENERAL INDUSTRIAL NOTES.................................. 41
NEW TRADE PUBLICATIONS.................................... 42

Prospect and Retrospect

AFTER 12 months of constantly increasing pressure on the foundry melt, labor unrest accompanied by insistent demands for higher wages and sky-rocketing prices of raw materials, what has the future in store for the casting industry? The wide gap that has been bridged within the span of a year is best reflected by the increase in the cost of pig iron which has advanced an average of $11 per ton, practically $1 per month. This whirlwind upward movement of metal quotations is unparalleled in the history of the trade and in a measure reflects the distorted conditions which prevailed throughout the entire year which has just come to a close. More chaotic than ever is the outlook for 1917. With conflicting negotiations for peace and equally conflicting preparations for carrying on the war on a more gigantic and terrible scale than in the past, the foundryman who can set sail and steer a straight course certainly is all-wise. No longer do values bear a normal relationship to one another, nor does there seem to be a possibility to correlate them under the present abnormal status to enable the foundryman to conduct his business except on a day-to-day basis. One crisis after another has been passed until all true perspective has been lost and it not only is possible, but altogether probable, that the present wrench threatening world conditions, regardless of what it may be, will find us mounting another crest of values almost epoch-making in its proportions. Foreshadowing even the immediate future, is an almost impossible task and what tomorrow will develop hardly can be judged by the developments of today. However, existing conditions are sufficiently interesting to merit consideration. The tonnage on the books of casting manufacturers will insure capacity operations beyond the first half at prices which are profitable unless another bulge in values again upsets all calculations. The demands of labor, to a large extent, have been met satisfactorily and the disturbances which beset operations in 1916 will hardly be repeated in their intensity. The transportation problem throughout the winter months will remain with us, and severe weather conditions will multiply the difficulties of its solution. Both common and skilled labor is scarce and difficult to satisfy and with immigration reduced to the minimum no relief is in sight. Therefore, the foundryman has only one recourse, namely, the quotation of prices that will cover all contingencies. Pig iron sales, on an average, will tax the output of stacks well through the third quarter, and in some instances deliveries are specified into 1918. Judged on the basis of future buying alone, the foundryman is assured of another year of unbounded prosperity beset with many pitfalls that will convert paper profits into actual losses unless every contingency is provided against. Casting producing capacity has been greatly increased and new projects under way promise to provide for a melt that will establish a new high record in the foundry trade. A year ago No. 2 southern foundry iron was quoted at $14.50, Birmingham, as compared with $24 today and in the north this grade was held at $19.95, Pittsburgh, against $31.95 at present. The advances in 12 months are well represented by these grades, although the price of prompt coke is limited only by the price which the purchaser is willing to pay. Pig iron quotations, in the leading centers, follow: No. 2, Chicago, $30; Philadelphia, $29.50; Buffalo, $35, and New York, $28.25; malleable, $30, Chicago, and $31.95, Pittsburgh. Lake Superior charcoal is firm at $31.75 to $32.75, Chicago.

New Shop Equipment for the Live Foundryman

Combination Electric Jar-Ramming and Power Rock-Over Molding Machine—Demonstrating the Reliability of Motor Drive

IN MOLDING machine design and construction the tendency is toward a combination of movements whereby manual labor is almost entirely eliminated. Henry E. Pridmore, Chicago, recently has combined the electric jar-ramming machine with a power-operated rock-over drop machine which rams the mold rolls it over, draws and returns the pattern. All of these operations are performed mechanically by one man. By pulling the clutch lever he starts ramming the mold; standing in one position, and with another lever, he rolls over the mold, draws the pattern and returns it to the jar-ramming table. The machine shown in the accompanying illustrations is a combination of the Pridmore 36 x 48-inch jar-ramming machine and a 48x48-inch power, rock-over drop, with a special drop of 24 inches, although the standard drop of this type of machine is only 16 inches. In Fig. 1 the pattern plate is on the table of the jar-ramming machine, in position to receive the flask prior to ramming the mold. In Fig. 2 it is shown rolled over with the pattern-drawing device in its elevated position ready to receive the flask and to lower it away from the pattern. In Fig. 3 the pattern-drawing device has been lowered in position to permit of the removal of the mold after which the pattern plate is rolled back onto the jar-ramming table in preparation for making another mold. One of the particular features of this machine is the support of the pattern-drawing frame to insure its absolute rigidity and freedom from sagging at any point when a mold is being lowered away from the pattern. In addition to the two guides at the back, a V-support has been bolted to the front of the frame, as shown in Fig. 2, which slides on a center post, thereby guiding and supporting the pattern-drawing frame at the front. The machine is operated by a combination of electric and pneumatic power, the jarring of the sand being accomplished electrically and the rolling over of the mold and the drawing and the return of the pattern are effected by compressed air. The machine weighs about seven tons.

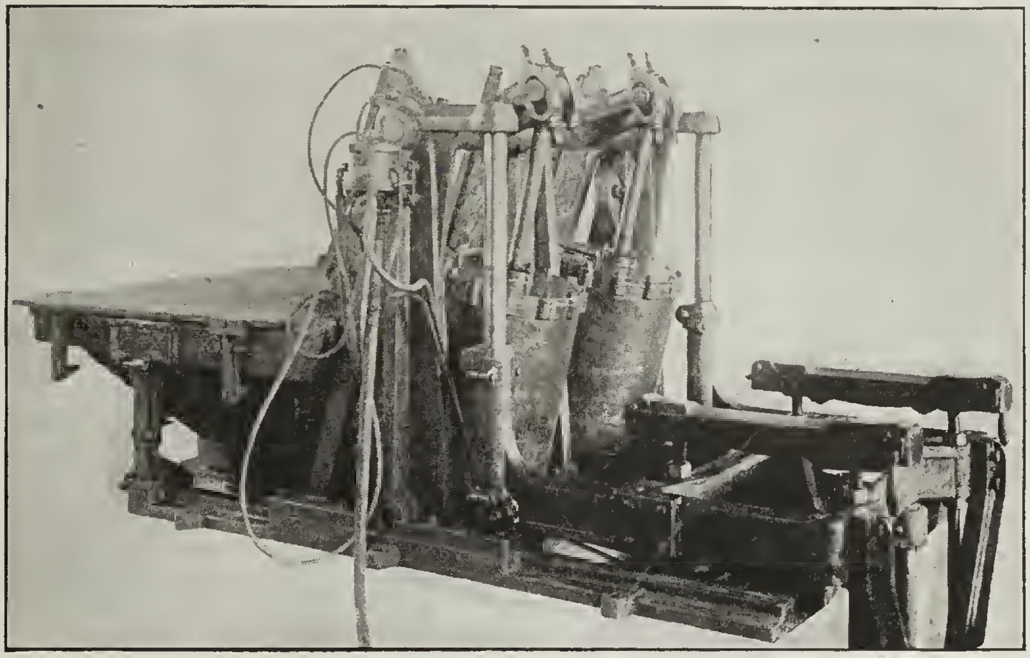


FIG. 1—COMBINATION ELECTRIC JAR-RAMMING AND POWER ROCK-OVER MOLDING MACHINE WITH THE PATTERN PLATE ON THE JAR-RAMMING TABLE READY TO RECEIVE THE FLASK

The Manitowoc Electric Implement Co., Manitowoc, Wis., has issued a six-page folder devoted to electric vibrators, showing their method of application to pattern plates, an electric vibrator with knee switch and three-wire converters where direct current is available. These machines are similar in appearance to an ordinary electric motor without pulley and a wiring diagram for a converter with several vibrators also is included.

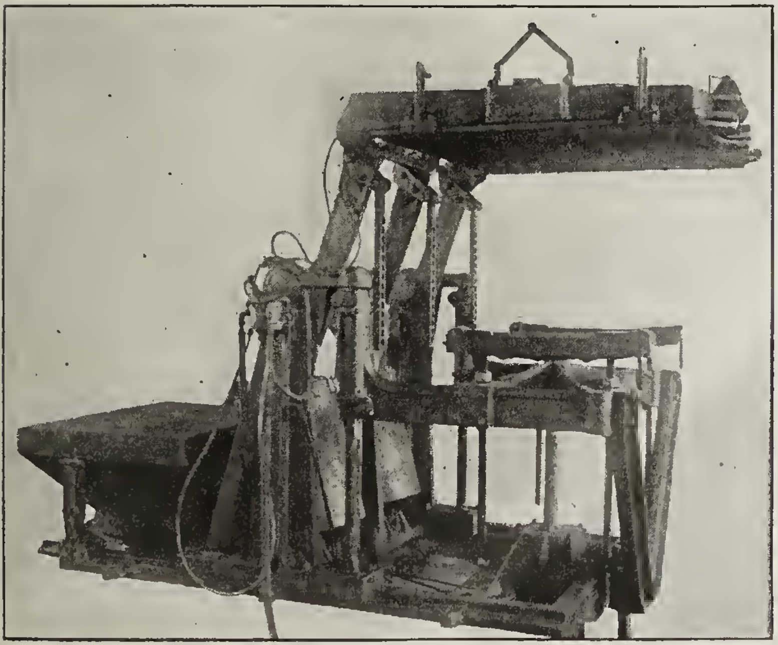


FIG. 2—PATTERN PLATE ROLLED OVER BEFORE DRAWING THE PATTERN

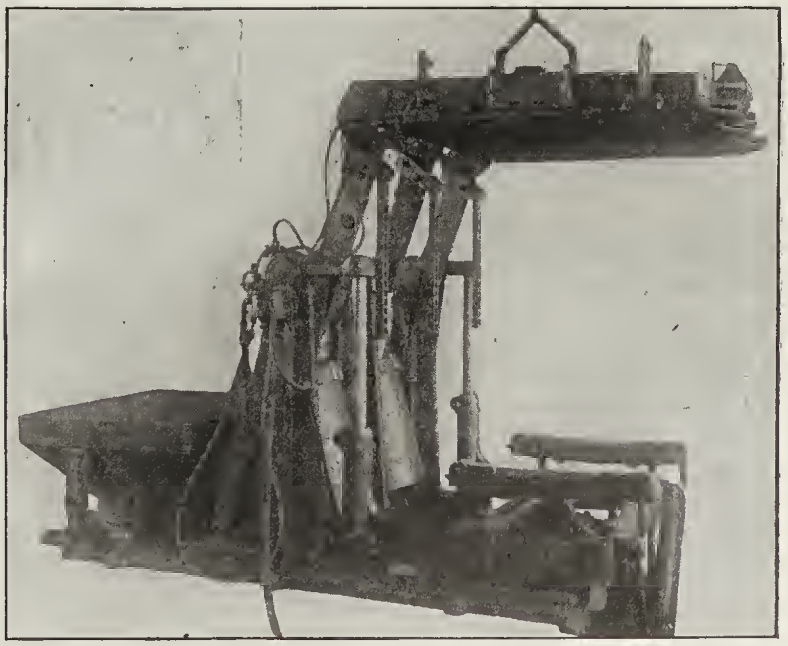


FIG. 3—PATTERN DRAWN AND PATTERN PLATE READY TO BE ROLLED BACK ONTO THE JAR-RAMMING MACHINE TABLE

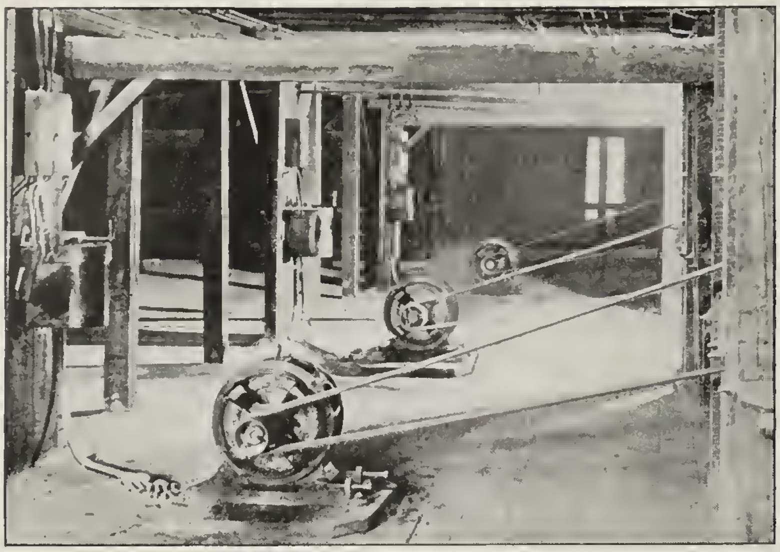


FIG. 1—MOTORS IN THE PLANT OF THE CLEVELAND SALT WORKS, CLEVELAND, WHICH HAVE OPERATED CONTINUOUSLY FOR A PERIOD OF 10 YEARS

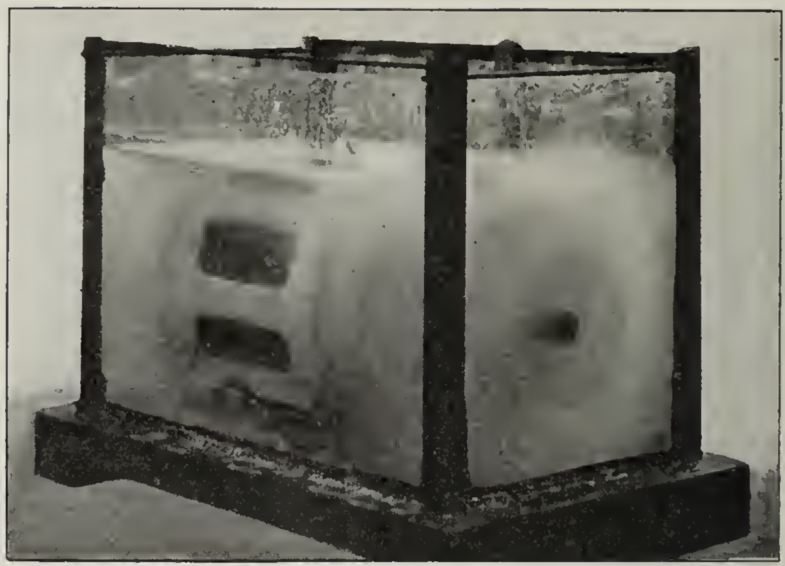


FIG. 2—THREE-AND-A-HALF-HORSEPOWER INDUCTION MOTOR RUNNING UNDER WATER, DEMONSTRATING THE QUALITY OF THE WATERPROOF INSULATION

Death of T. L. Griffith

T. L. Griffith, a prominent figure in the foundry supply trade for a period of nearly one quarter of a century, died at his home, Cape Girardeau, Mo., Nov. 25, aged 54 years. At the time of his death he was secretary and general manager of the Cape Girardeau Portland Cement Co., with which he was affiliated for about five years. Mr. Griffith gained his first experience in the foundry supply industry in the capacity of bookkeeper for the S. Obermayer Foundry Supply Co., with headquarters at Cincinnati, and in 1890 this company was incorporated under the name of the S. Obermayer Co. and Mr. Griffith was elected president. He continued to occupy this office until 1896, when he and John Hill, of the Hill-Brunner Foundry Supply Co., organized the Hill & Griffith Co. In 1901 he severed his relations with the latter and located at Hamilton, O., under the firm name of the T. L. Griffith Co. Subsequently he went to Missouri and engaged in the manufacture of cement. Mr. Griffith is survived by two daughters.

Demonstrating the Reliability of Motor Drive

That the electric motor is adapted to operation under the most severe service conditions, such as are induced by dust, moisture, etc., has been satisfactorily demonstrated by the Lincoln Electric Co., Cleveland. Eight years ago this company exhibited one of its standard induction motors in constant operation, entirely submerged in water and this display attracted such wide attention that it since has been made at many conventions and meetings of manufacturers and others interested in the use of power. Furthermore, the practical value of this test has been proven in many cases where the motor, in actual service, has given good results under even more severe tests than submerging in water. An instance of this is a motor installation at the plant of the Cleveland Salt Works, Cleveland. Here the motors have operated in rooms where salt is always present and this has caked into the windings until they are hardly visible, as illustrated in Fig. 1. These motors were installed 10 years ago, but in spite of the severe service conditions there has not been a single shutdown, for motor trouble throughout this period. Similarly, in other plants where dust has been a troublesome factor, it has been demonstrated that the electric motor is an exceedingly satisfactory machine, notwithstanding the severe service conditions. The Lincoln Electric Co., which has developed this motor drive test, manufactures induction motors from one-half to 500 horsepower.

T. L. GRIFFITH

"Corkboard Insulation for Cold Storage Rooms," is the title of a 28-page booklet issued by the Armstrong Cork Co., Pittsburgh, and a pamphlet containing four pages describes insulating services of this cork covering on an 8-inch brine line, which was in service for a period of 15 years.

Casting Malleable Iron in Permanent Molds

By *Richard Moldenke*

Question:—Kindly advise us what progress has been made in making small malleable iron castings in metal molds?

Answer:—The use of the permanent mold in the malleable foundry has not made the progress it deserves. This is unfortunate since from the standpoint of the metal to be poured, the composition required must be such that it is white in fracture whether cast in sand or in iron molds. Malleable cast iron is made either in the air furnace or the cupola, although the most advanced practice utilizes the open-hearth furnaces and latterly, the electric furnace. So far as the casting operation is concerned, the problem narrows down to two propositions. The molten metal is available either in a mass, as in the case of a 10-ton furnace heat, which should be disposed of within three quarters of an hour, or the metal comes ladle by ladle from the cupola and its casting is spread over a period of several hours, or possibly all day long.

Suppose a foundry has an order for several thousand castings of a kind? If melting is done in the air furnace, it is manifest that a series of permanent molds must be provided for the same casting, as the output per heat will be limited to the number that can be cast during a short period of time in the molds provided, or hardly faster than one every two minutes or so. In the case of the cupola fewer molds will do, as the heat is spread over more time.

Molds cost money when they are made of iron and require much finishing. If it is possible to make only about 25 castings per heat from every iron mold provided, with the usual three or four heats a day in fairly large foundries, this means less than 100 castings. Considering that in exceptional cases only will there be a straight run of a given pattern of perhaps 50,000 pieces before some change in lettering, etc., is necessary, the expense for iron molds quickly becomes prohibitive. Even for the ideal casting in this line, the tie-plate, the orders received will not be large enough to warrant making many molds at a time, as identification figures, dates, etc., may be changed for the next batch required.

Therefore, only in exceptional cases will it pay to depart from the ordinary sand mold operation. The larger and heavier the casting, the more nearly the casting is a standard one, remaining the same year in and year out, the more likely will the iron mold be found in the direction of economy. The smaller and lighter the casting and the smaller the quantities required, the less the likelihood of success with iron or even long-life molds.

Iron molds are used in some malleable foundries at the present time, but only in connection with regular sand molds to increase the output per heat. The development in question is probably more of an experimental nature and undoubtedly, will lead to some less expensive system of making molds other than of sand which may not have the long life of the iron ones, but which can be quickly made and changed and serve their purpose for both gray iron and malleable where great production of the same casting is required.

Personal

C. J. Houck has been appointed superintendent of the malleable foundry of the Timken-Detroit Axle Co., Canton, O., to succeed the late S. J. Campbell.

J. S. See, until recently affiliated with the General Motors Co., Detroit, has been appointed engineer in charge of production of the Industrial Works, Bay City, Mich.

John Trueman, formerly affiliated with the American Seating Co., Buffalo, has been appointed foreman of the foundry operated by the Miller Improved Gas Engine Co., Springfield, O.

Arthur V. Farr, advertising manager of the S. K. F. Ball Bearing Co., Hartford, Conn., during the past three years, has accepted the position of sales manager of the Hess Steel Corp., Baltimore, Md.

Louis Ferster, who has been located at the home office of the Werner G. Smith Co., Cleveland, manufacturer of oil core binders, has been appointed manager of the eastern office of this company, located in the American Express building, Rochester, N. Y.

Alex. T. Drysdale has been appointed superintendent of the Birmingham, Ala., plant of the United States Cast Iron Pipe & Foundry Co., having been transferred from this company's plant at Burlington, N. J.

Arthur H. Young, who has been supervisor of labor and safety of the Illinois Steel Co., Chicago, for a number of years, has been appointed director of the American Museum of Safety, New York, and will assume his new duties on Jan. 1.

J. W. Bass has been appointed works superintendent of the Universal Plow Co., Florence, S. C. Three months ago Mr. Bass accepted a position as superintendent of this company's plant, prior to this time having been affiliated with the malleable casting works of the Stanley G. Flagg Co., Stowe, Pa., in the capacity of general foundry foreman.

W. H. Goldstine, superintendent of the brass and aluminum foundry operated by the Buick Motor Co., Flint, Mich., has organized a company to reopen the United States Brass & Iron Foundry Co.'s plant at Flint, Mich., under the firm name of the United States Iron Foundry Co. The foundry will specialize in castings for automobile work and the plant will be placed in operation about Jan. 1.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

A foundry, 62 x 72 feet, is being erected by the Benthall Machine Co., Suffolk, Va.

The Troy Engine & Machine Co., Troy, Pa., will build a foundry, 50 x 194 feet.

An addition will be erected to the foundry of Maher & Flockhart, Newark, N. J.

The Stover Mfg. Co., Freeport, Ill., contemplates building an addition to its plant.

The Seaton Foundry Co., Atcheson, Kas., will build a foundry, 100 x 175 feet.

R. Lavin & Son, East Chicago, Ind., will build a foundry, 50 x 150 feet.

The Samuel L. Moore & Sons Corporation, Elizabeth, N. J., will shortly build a 40 x 200-foot addition to its foundry.

The Pittsburgh Crucible Steel Co., Pittsburgh, will erect a large plant for the manufacture of steel castings at East Liverpool, O.

A contract has been awarded by the National Malleable Castings Co., Cleveland, for the erection of a large addition to its plant.

D. J. Hauptman, 139 North Clark street, Chicago, will erect a foundry at 1738 North Kolmar avenue at a cost of $15,000.

The Mansfield Foundry Co., Mansfield, Mass., has acquired the old Rider foundry and is building an addition, 60 x 100 feet.

G. W. Buttley, of the Silent Washer Co., Appleton, Wis., is active in the organization of a company to build a malleable foundry.

A large addition is being erected to the plant of the Krupp Foundry Co., Ltd., Lansdale, Pa.

The Rundle Mfg. Co., Milwaukee, manufacturer of plumbers' supplies, will erect an addition to its plant.

A contract has been let by Taylor & Co., 680 Morgan avenue, Brooklyn, N. Y., for the erection of a foundry, 50 x 200 feet.

The Washington Iron Works, Seattle, Wash., will build an addition to its foundry, 48 x 72 feet.

Plans are being prepared for a foundry and warehouse to be erected for the Peerless Foundry Co., Indianapolis, Ind.

A contract has been awarded by the Atlantic Steel Castings Co., Chester, Pa., for a 60 x 76-foot addition to its steel foundry.

The Compressed Steel Shafting Co., Boston, Mass., has purchased 152,000 square feet of land, on which it will erect a foundry.

The East Deering Foundry Co., East Deering, Me., recently incorporated, contemplates building a foundry, 40 x 100 feet.

Plans are being prepared for a malleable foundry, 60 x 140 feet, and an annealing building, 60 x 80 feet, to be erected for the Standard Wheel Works, Terre Haute, Ind.

The Avery Co., Peoria, Ill., manufacturer of agricultural implements, is erecting a two-story, 50 x 70-foot foundry at a cost of $15,000.

The H. A. May Foundry Co., Philadelphia, has started the erection of a 60 x 150-foot foundry addition to its plant at Thirtieth and Ludlow streets.

The Franklin Foundry Co., Franklin, Pa., will build a steel-frame foundry, 60 x 126 feet, the materials for which have been purchased.

The Bay City Foundry & Machine Co., Bay City, Mich., is building an addition to the plant of the M. Garland Co., which it recently purchased.

Two foundry additions, 34 x 98 and 56 x 140 feet, respectively, will be erected by the Franklin Machine Co., 189 Charles street, Providence, R. I.

The Enterprise Foundry Co., South Wilmington, Del., contemplates enlarging and improving the plant which it recently purchased from W. M. Myers.

The Nova Scotia Coal & Steel Co., New Glasgow, N. S., Can., has started the erection of a large foundry for making steel castings for its car shops.

Work has been started on the erection of a 40 x 60-foot addition to the plant of the

Canadian Malleable Iron Co., Owen Sound, Ont., Can.

The Mueller Mfg. Co., Sarnia, Ont., Can., contemplates doubling its present output of brass castings by the erection of an addition and the installation of new machinery.

A contract has been awarded for the erection of an 80 x 100-foot addition to the malleable foundry of the American Radiator Co., Buffalo.

A contract has been awarded for the erection of a one-story, 100 x 105-foot addition to the plant of the M. W. Kellogg Co., Jersey City, N. J., founder and machinist.

The Ladle Mfg. Co., New Philadelphia, O., recently incorporated to engage in the foundry business with $50,000 capital, has taken over the plant of the Spicer Mfg. Co. and will build machine and pattern shops.

The Riverside Foundry & Machine Works, Chicago, will build a machine shop, 42 x 132 feet, at a cost of $12,000. Heimbeck & Bacon, 852 East Sixty-third street, are the architects.

The Utah Copper Co., Garfield, Utah, is building an addition to its foundry, 82 x 90 feet and a brass foundry also is being added. The equipment for the addition and the new brass shop now is being purchased.

The Pechstein Iron Works, Keokuk, Ia., will build a foundry, pattern shop and office, the construction of which is expected to be commenced in the spring, when bids may be taken for additional machinery equipment.

Plans are being made for a foundry, 113 x 240 feet; a pattern shop, 40 x 60 feet; a storage building, 40 x 40 feet and an office building, 30 x 34 feet, to be erected for the Warman Steel Casting Co., 650 South Los Angeles street, Los Angeles, Cal.

A contract has been let by the Canadian Steel Foundries, Welland, Ont., Can., for the erection of two open-hearth furnaces and a machine shop extension. The estimated cost of the additions, including machinery to be installed, is $500,000.

The Gilliam Mfg. Co., Canton, O., has changed its name to the Gilliam Co. and is increasing its capital stock from $350,000 to $800,000. The plant of the John Danner Mfg. Co., has been purchased and a foundry, 175 x 310 feet, will be erected.

A $50,000 plant, 100 x 260 feet, will be erected on a 12-acre site at State road and the Belt line, Cleveland, recently acquired by C. H. Miller, formerly of the Champion Stove Co., of that city. A general jobbing foundry business will be conducted, including the manufacture of stove and other castings.

The Southern Iowa Machinery Co., Centerville, Ia., recently incorporated by A. W. Judy, president and manager; D. A. Lee, secretary and D. W. Barnett, treasurer, has acquired the Goss foundry and machine shop. The plant will be enlarged and considerable new equipment will be installed.

General Industrial Notes

The Lavelle Foundry Co., Anderson, Ind., has increased its capital stock from $10,000 to $25,000.

The Equipment Mfg. & Foundry Co., Buffalo, has been incorporated with $150,000 capital stock by W. H. Scott, L. A. Findley and E. B. Kenngott.

The Precision Die Casting Co., Syracuse, N. Y., has been incorporated with a capital stock of $215,000 by H. S. Tenney, W. J. Knapp and T. G. Meacham.

The Smidth-Lewis Co., Elizabeth, N. J., recently incorporated with a capital stock of $10,000, will establish an iron foundry at North avenue and Meadow street.

NEW TRADE PUBLICATIONS

AIR COMPRESSORS.—A 24-page bulletin, published by the Ingersoll-Rand Co., New York City, illustrates and describes the Ingersoll-Rogler straight line, power-driven air compressor. Numerous halftone illustrations of various parts of the machine are included and its construction is described in detail. A 16-page bulletin devoted to riveting hammers also has been issued.

PORTABLE ELECTRIC HOISTS. — A four-page bulletin has been issued by the Chicago Pneumatic Tool Co., devoted to its line of portable electric hoists, which are adapted for handling materials in foundries, machine shops, etc. The hoist is of the worm gear type, with two hoisting drums, one located on each side of the worm gear. It is built in three sizes with capacities of 250, 500 and 1,000 pounds. Another bulletin issued by this company is devoted to accessories for pneumatic tools, such as hose, hose couplings and hose clamp tools.

MULTIVANE FANS.—A new line of multivane fans, known as design 3, is considered in a 100-page catalog recently issued by the B. F. Sturtevant Co., Hyde Park, Mass. This line of fans has been developed mainly to provide fans of this type which will have a larger outlet area for a given volumetric capacity, causing the highest mechanical efficiency to occur at a lower velocity for a given maintained resistance. To accomplish this the proportions of the casing have been changed. Dimensions, capacities, horsepower, etc., for fans having different discharge openings are included.

ELECTRIC FANS.—A 60-page catalog issued by the B. F. Sturtevant Co., Hyde Park, Mass., is devoted to motor-driven fans built by this company. The fans described include centrifugal, propeller and disc types. The centrifugal fans are installed to supply fresh air or air under pressure and to remove foul air. The propeller fans exhaust foul air from rooms, halls or similar enclosed spaces, but will not deliver air against much resistance and therefore they will not operate to advantage in connection with long piping or ducts. The disc fans are used for the same classes of service as the propeller fan. A large amount of data are included covering pressures, volume, sizes, etc., to guide in the selection of a small fan for any specific purpose.

PNEUMATIC COLLECTING AND CONVEYING SYSTEMS.—A comprehensive, 74-page catalog illustrating and describing fan systems for collecting dust and conveying materials is being distributed by the B. F. Sturtevant Co., Hyde Park, Mass. The advantages of pneumatic systems for collecting dust are pointed out and many installations of such plants in the cleaning rooms of foundries to convey the dust from tumbling barrels, grinding wheels, sand-blast systems, woodworking machinery and pattern shops, etc., are illustrated. The catalog, in addition, contains details of the fans, dust collectors, pipes, etc., necessary for such installations and many valuable tables are included of velocity, volume and horsepower when air under pressure escapes into the atmosphere, pressure and horsepower lost by friction of air in pipes 100 feet long, weight of round galvanized iron pipe and elbows, pressures in ounces per square inch, height of water columns in inches, etc. The catalog should prove to be a valuable addition to the library of every foundry engineer.

FUEL OIL ENGINES.—A 28-page bulletin issued by the Chicago Pneumatic Tool Co., Chicago, is devoted to its extensive line of low-grade fuel oil engines. These are guaranteed to operate on any mineral oil of 28 degrees Baume or lighter, containing not over 1 per cent of sulphur. The engine is of the horizontal, straight line, single cylinder type with crosshead. In the larger size it is mounted on a substantial sub-base so designed that when it is in operation it is free from vibration. These engines are suitable for many purposes and have been adapted for driving electric generators, fans, blowers, exhausters, centrifugal and horizontal pumps, vertical triplex pumps, hoists, line shafting, etc. The bulletin is well illustrated and shows the construction of the engine in detail.

RHEOSTATS AND PANELS.—A bulletin issued by the General Electric Co., Schenectady, N. Y., containing 20 pages, is devoted to speed-regulating rheostats and panels for direct-current motors. These instruments are shown in various combinations and tables of dimensions are included. Three bulletins also have been published by the General Electric Co. showing three types of meters, one designated as a printometer, being designed for use in connection with a watthour meter whereby, at regularly recurring time intervals, a printed record is made of the total energy consumption as registered by the watthour meter. Another instrument is for use in connection with a watthour meter to obtain the maximum demand. It consists essentially of the demand registering and a timing mechanism mechanically-connected and mounted within the same case. A third meter is for use with watthour meters and provides a graphic record which shows not only the average demand during every interval of the day, but also the time of day and day of the week each amount of energy is delivered.

ABRASIVE GRINDING WHEELS. — A comprehensive catalog, containing 110 pages, devoted to the extensive line of grinding wheels manufactured by the Abrasive Co., Philadelphia, illustrates and describes their boro-carbone and electrolon abrasive wheels. Boro-carbone is an oxide of aluminum in crystalline formation and is produced by fusing bauxite by the arc process in an electric furnace. Its physical formation is such that it leaves sharp cutting points when fractured and this characteristic makes it highly efficient for grinding all kinds of steel and materials of high tensile strength. Electrolon is carbide of silicon in crystalline form and is made of coke, sand, salt and sawdust. Wheels made of this material are recommended for grinding cast iron, brass, bronze, etc. The process of manufacture is described and a table for the selection of grain and grade of these two types of wheels for different classes of work is included. A table of grinding wheel speeds also should prove valuable. Price lists of wheels of different sizes and shapes are given. The catalog is well illustrated throughout.

THE FOUNDRY

Vol. 45 No. 2 Cleveland, Ohio, February 1917 Whole No. 294

Designing a Modern Foundry of Moderate Size

Features of a New England Gray Iron Shop Arranged for a Side-Hill Location—Castings for Submarines Included in Output

NO ACCURATE census of American foundries according to their capacity has ever been made, but a careful survey of the field indicates that among the gray iron shops, the number of plants with a daily capacity of less than 30 tons considerably exceeds those with a larger output. Many foundrymen, therefore, are not directly interested in the problems of the large shop pouring 50 to 100 tons a day; they are more vitally concerned with the design and operation of plants of moderate size ranging from 10 to 30 tons daily capacity.

The existing state of progress in the foundry industry, however, makes it necessary for the small shop to be as carefully designed and thoroughly equipped as its larger contemporary. As a result, there are an unusually large number of new, small or moderate-sized shops in the country that represent as much intensive study in their design and construction as those operated by the largest corporations. This situation indicates a uniformly healthy condition of progress and prosperity in the foundry industry.

Among the plants of the character just discussed, that operated by the New London Ship & Engine Co., Groton, Conn., is a conspicuous example. It has a daily capacity of about 80 tons of gray iron castings and embodies many modern features in its construction and arrangement.

This plant is laid out to take care of the future as well as the present, and for the time being the output from one cupola is from 6½ to 8 tons per day. The castings undergo a severe inspection since most of them go into Diesel engines for naval submarines. Approximately 92 men are employed, including 25 molders and 23 coremakers. The intricate character of the work is reflected in these figures, inasmuch as the number of skilled molders and coremakers per ton of output is well above the average.

Fig. 1 shows the general arrangement of the plant. As this illustration indicates, the shop is located on a side-hill, in a rather restricted area. The designing engineers took advantage of the conformation of the ground by placing the cleaning room, sand bins, heating plant, etc., in the basement, with standard gage tracks on the basement floor level for the receipt and shipment of materials. The size of the plant can be practically doubled by extending the building to the north.

The building was designed by French & Hubbard, engineers and architects, Boston. It was erected by H. R. Douglass, New London, Conn..

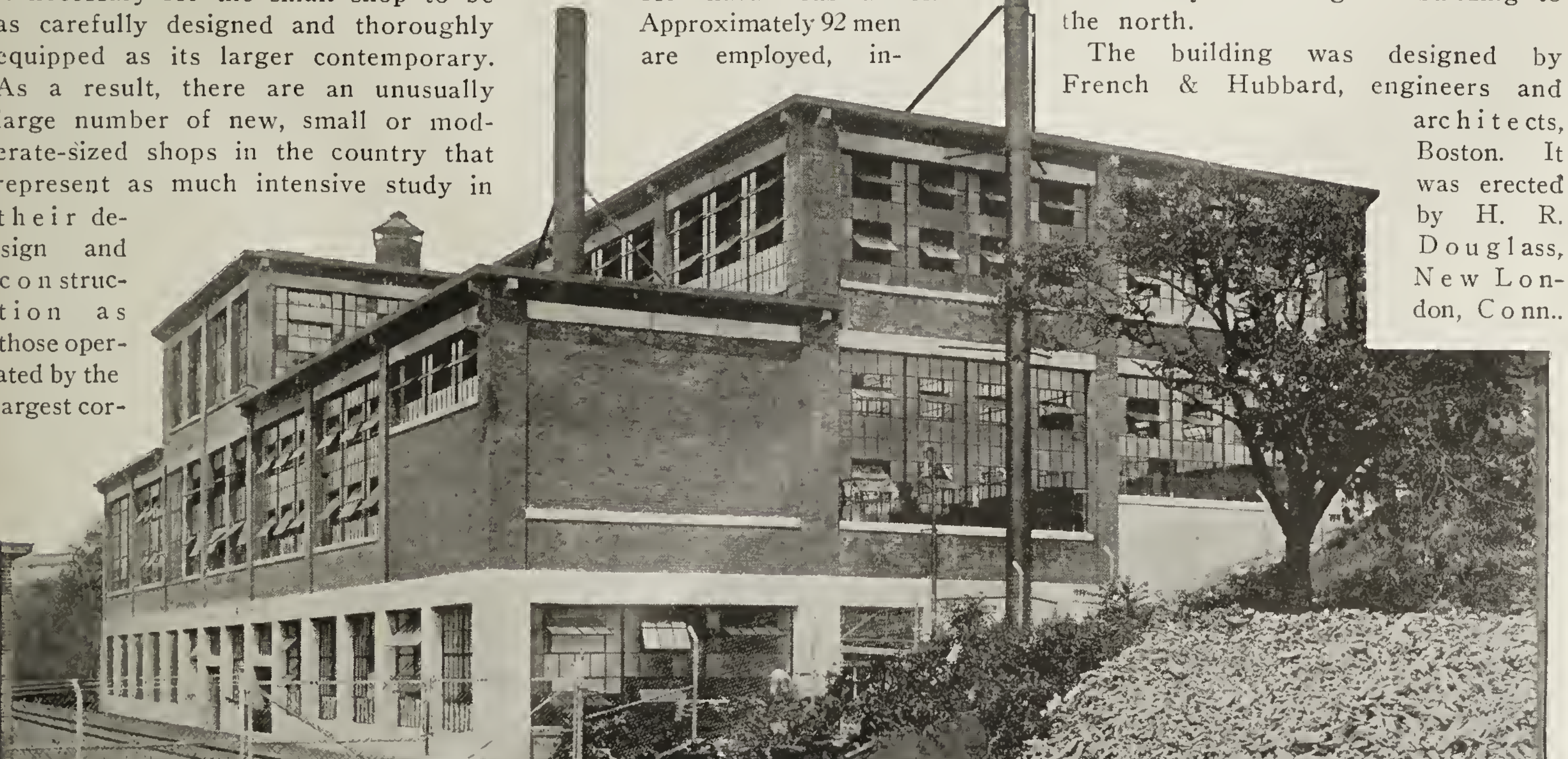


FIG. 1—EXTERIOR OF BUILDING FROM SOUTHWEST SHOWING ARRANGEMENT OF FLOORS TO ACCOMMODATE SIDE-HILL LOCATION

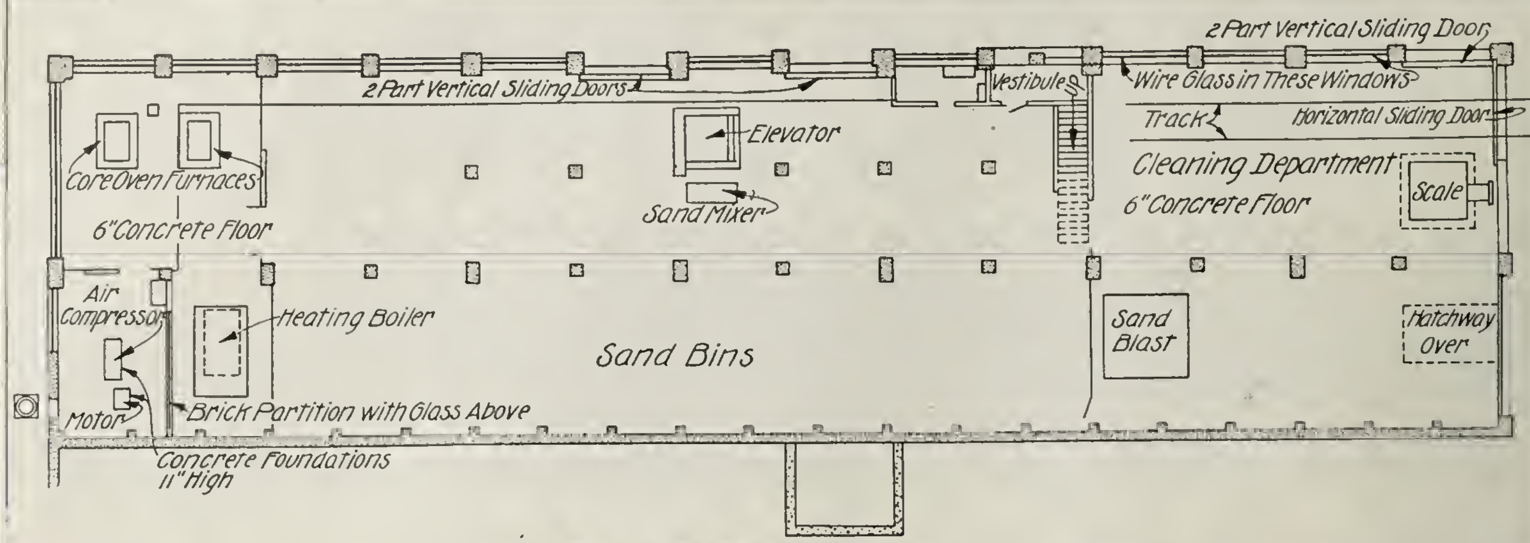


FIG. 2. BASEMENT

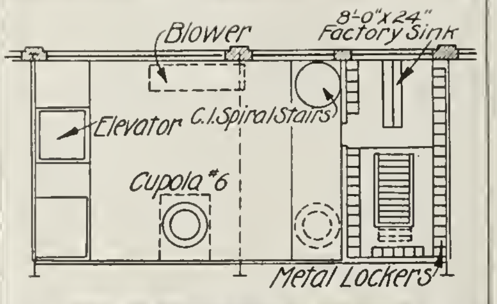


FIG. 3. MEZZANINE FLOOR

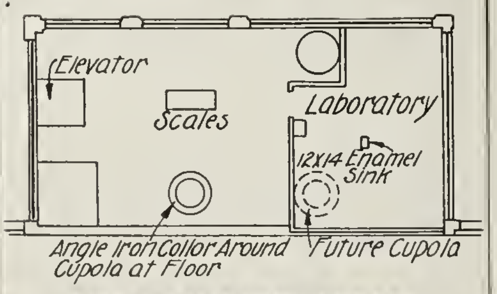


FIG. 4. CHARGING FLOOR

Fig. 2—Plan of basement showing arrangement of sand bins, cleaning room and heating apparatus—This floor is connected to the molding floor by a 4,000-pound elevator and by hatchway commanded by crane; Fig. 3—Plan of arrangement of blower and locker rooms—Each workman has an individual steel locker; Fig. 4—Plan of charging floor and laboratory—The latter is unusually completely equipped; Fig. 5—Plan of main floor showing core room, molding floor, drying oven and melting equipment — Eventually three types of furnaces will be installed including cupolas for ordinary gray iron, and an air furnace for steel castings

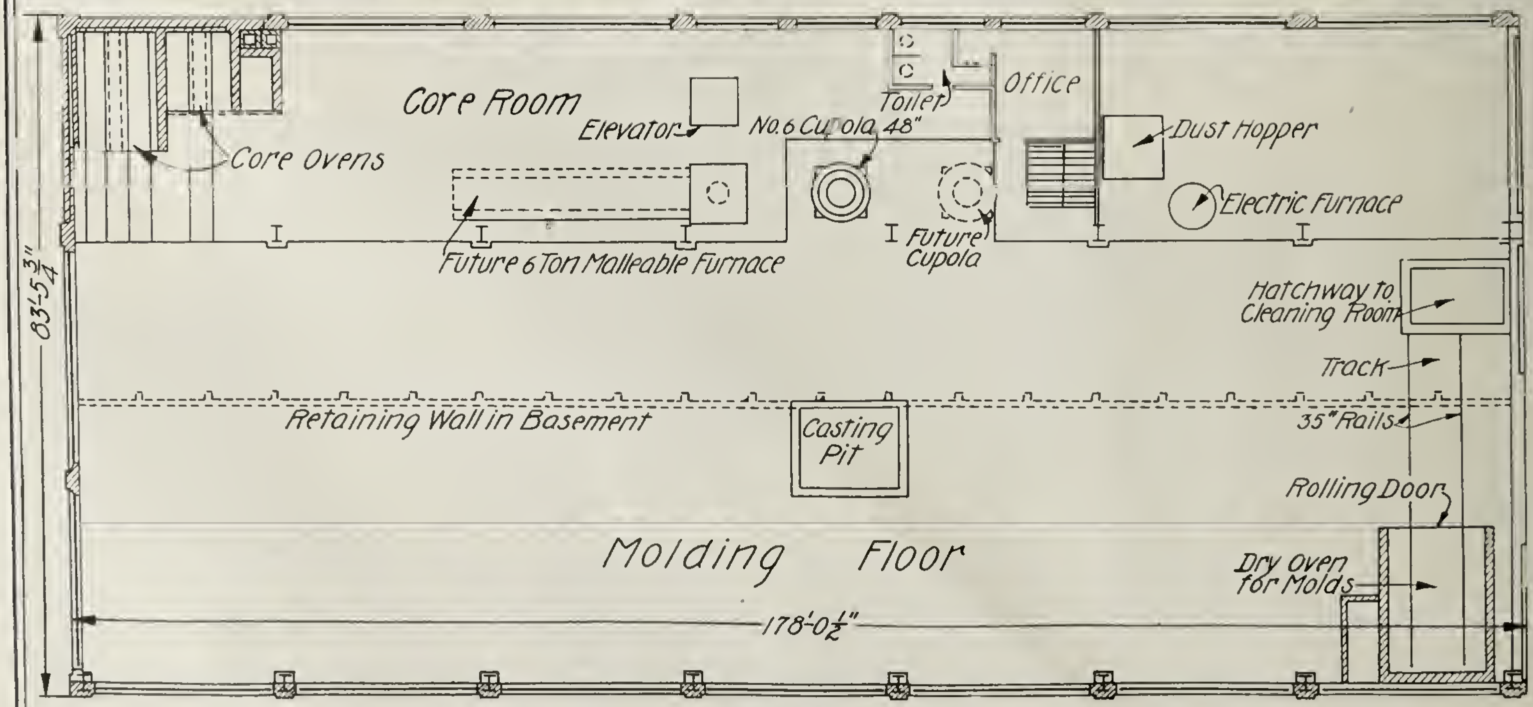


FIG. 5. MAIN FLOOR

general contractor. The steelwork was fabricated by the Eastern Bridge & Structural Co., Worcester, Mass.

The structure is 178 feet in length and 83 feet in width. The steel frame carries concrete and brick curtain walls and steel sash. Over 85 per cent of the wall area is glass, resulting in unusually satisfactory lighting in all departments. The steel columns carrying the walls, roof and main crane runway are spaced on 25-foot centers. The basement, as indicated in Fig. 1, extends under about half of the building, being 45 feet in width. The location of the basement retaining wall is clearly shown in the plan, Fig. 5. The molding floor is divided by the crane runway into main and side bays, the former being 56 feet and the latter 27 feet wide. The cupolas, core room, bench molding floor, etc., are located in the side bay. As previously mentioned, the cleaning room is located in the north end of the basement, under the main and side bays. A 7 x 11-foot hatchway is cut in the molding floor through which the castings are transferred to the cleaning room.

Warm, Fresh Air is Assured

The heating and ventilating problem has been carefully worked out. Heat is furnished by a hot water system furnished by the American Radiator Co., Chicago, and sufficient radiation has been provided to maintain the foundry at an even temperature of 60 degrees in the coldest weather, if desired. The molding room is kept clear of gas and fumes by two 48-inch roof ventilators connected to positive-acting, motor-driven fans furnished by the B. F. Sturtevant Co., Hyde Park, Mass. Each fan is direct-connected to a 7½-horsepower, 220-volt, 15-ampere, direct-current motor operating at 410 revolutions per minute. These ventilators maintain a constant circulation of air and even while pouring, the shop is practically clear of fumes. The ventilators are so arranged that they operate by natural draft when the fans are not running. The entire heating and ventilating system more than meets the requirements of the Connecticut law and represents a distinct step in advance.

The problem of artificial illumination has been worked out with equal care. Nitrogen-filled lamps are suspended over the crane runway in the main bay. In addition, four powerful lights are suspended from the crane girders, as shown in Fig. 6. The side bay, basement, mezzanine and charging floors are illuminated by ceiling and bracket lamps. The lamps are controlled from switch boxes located at convenient points. These boxes contain switches for each light. Electricity is supplied at 110 volts, alternating current and 220 volts, direct current. The direct current is utilized principally for power purposes.

Nearly every column on the molding floor is provided with outlet plugs about 4 feet from the floor level for connecting extra lights or electrically operated appliances. An equal number of compressed air outlets are provided for the operation of air hammers, pneumatic rammers and other tools. The air pipe-line carries a pressure of 90 pounds per square inch. The air is furnished by a motor-driven compressor, built by the Chicago Pneumatic Tool Co., Chicago. The compressor, which is belted to the motor, operates at 160 revolutions per minute and delivers 193 cubic feet of free air per minute.

Complete Crane Service

The various departments are provided with electric cranes of a suitable character for handling materials and in addition, 24-inch gage industrial tracks in the basement and on the molding floor afford convenient access to the sand and bulk material bins. A 4,000-pound electric elevator, furnished by the Otis Elevator Co., New York, connects the basement with the various upper floors including the charging platform.

The main bay, or molding floor, is served by a 5-ton 3-motor Whiting crane with a span of 53 feet. This crane operates on 220-volt direct current. The core room in the side bay is provided with a 1-ton, floor-operated crane and the cleaning room in the basement is equipped with a 3-ton Whiting crane with a span of approximately 22 feet. The crane equipment on the molding floor will shortly be supplemented by a 10-ton Niles crane which will operate on the same runway as the present 5-ton crane.

The arrangement of the melting equipment is shown clearly in Fig. 5. Space is provided for two cupolas, one of which has been installed. This cupola was furnished by the Whiting

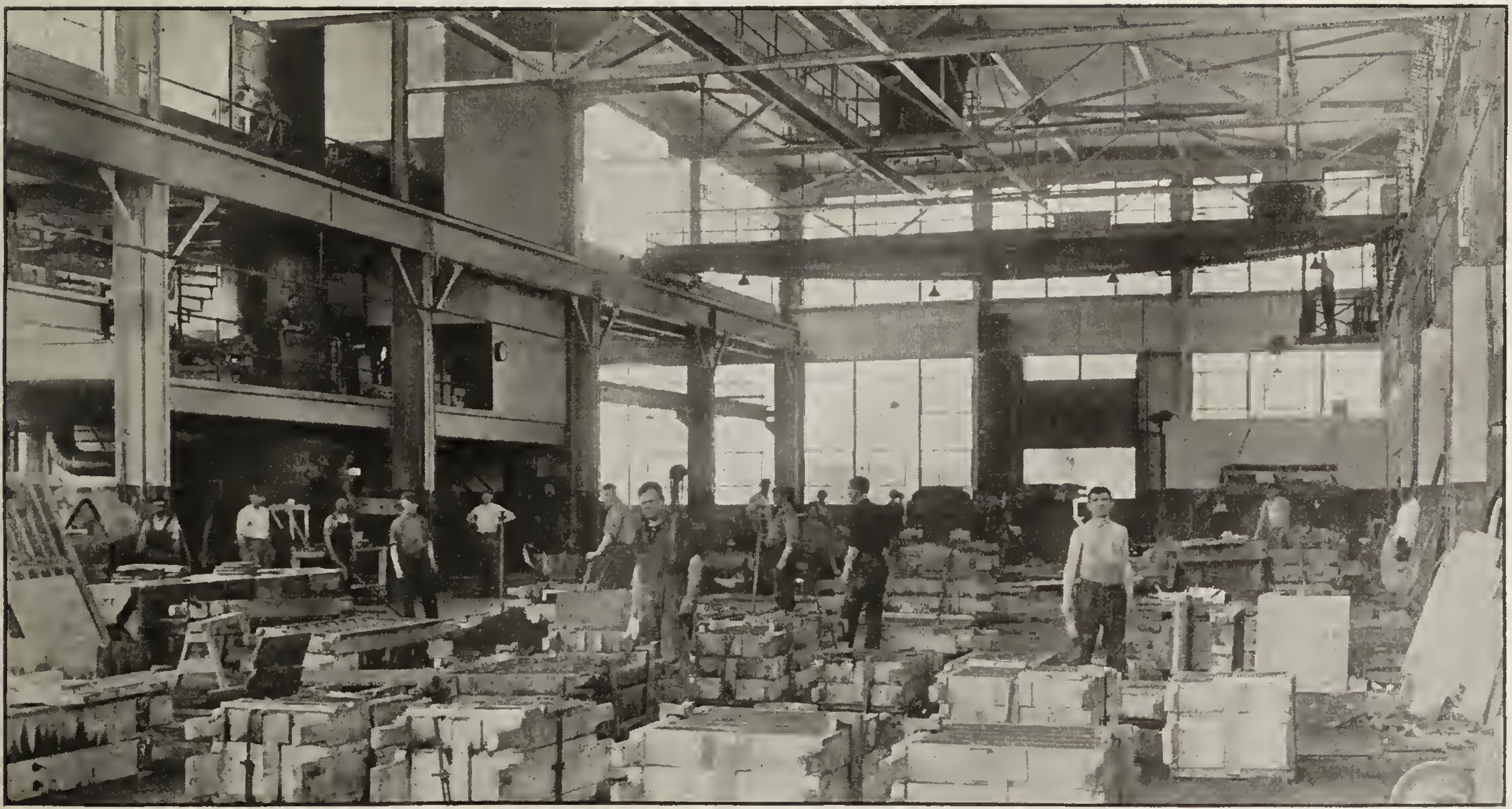


FIG. 6—GENERAL VIEW OF MOLDING FLOOR SHOWING MELTING AND CRANE EQUIPMENT

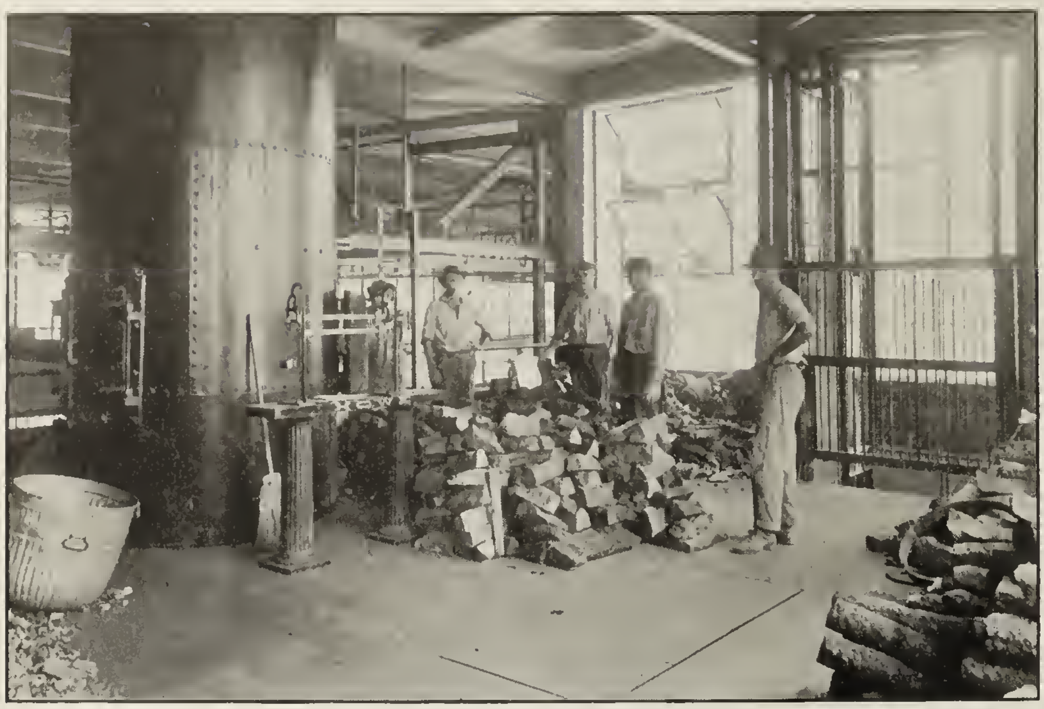


FIG. 7—THE CHARGING FLOOR IS FACED WITH STEEL PLATE

Foundry Equipment Co., Harvey, Ill. It has a shell diameter of 48 inches and is lined to 42 inches, giving it a capacity of 6½ to 7 tons per hour. A 1½-ton Snyder electric furnace will be installed shortly for making light steel castings, and later on a 6-ton air furnace may be provided.

The blast for the cupola is furnished by a positive-pressure, Wilbraham-Green blower, built by Wonham, Bates & Goode, New York. The blower is driven by a 30-horsepower variable speed direct-current motor. At its normal speed of 750 revolutions per minute, it furnished 9½ ounces blast pressure. The pressure is measured by a water gage of the ordinary type, and in addition, the volume is indicated by a blast-meter furnished by Charles J. Clark, Chicago. The blower is located on a mezzanine floor situated between the molding and charging floors. Locker and toilet facilities also are provided on this floor.

The charging floor, Fig. 4, is 31 feet long and 24 feet wide. It is served by the 4,000-pound elevator previously mentioned and also is reached by a spiral iron stairway. A 2-ton scale is provided for weighing charges. The floor is reinforced concrete protected on the upper surface with ⅜-inch steel plate.

The hot metal is handled in crane and hand ladles of the usual type, the largest ladle in use at present having a capacity of three tons. The iron in the cupola drop is recovered in a 24 x 36-inch cinder mill operated by a 2-horsepower, direct-connected General Electric motor.

The molding floor is 53 x 175 feet, with an area of 9,275 square feet. The north half of the floor is devoted to dry-sand and the south half to green-sand molding. A 10 x 12-foot casting pit is located in the center of the floor, directly in front of the cupola. A car-type mold-drying oven is situated in the northeast corner of the molding room, as indicated in Fig. 5. It is 18 feet long, 12 feet wide and 10 feet high and is provided with a Kinnear rolling door.

A great variety of gray iron castings are produced ranging in weight up to 2,500 pounds. The castings include cylinders, engine beds and other submarine parts. The cylinders are molded singly. The pistons are molded vertically in 18-inch Sterling flasks. All the castings are provided with lugs which are tested by government inspectors before the work is released to the machine shop.

A 40 x 50-inch jarring machine built by the Herman Pneumatic Machine Co., Pittsburgh, is installed on the molding floor. Several squeezer machines also are provided for light work.

The molding and facing sand is stored in 10 bins located in the basement. The industrial railway previously mentioned is utilized to transfer the sand from the bins to the points on the molding floor where it is needed. Since the sand is stored under cover in a heated room, there is no difficulty from freezing in the winter. The core and facing sands are mixed in a Blystone mixer placed near the elevator in the basement. This mixer is driven by a 3-horsepower Fairbanks-Morse motor. An electrically-operated sand-sifter manufactured by the Champion Foundry Machinery Co., Chicago, also is provided.

The core room occupies an area 27 x 60 feet in the southwest corner of the side bay. Its general arrangement is clearly shown in Fig. 8. Three core ovens have been installed; two are of the car type while the third is of the drawer type. The larger car-type oven is 15 feet long, 10 feet wide and 8 feet high; the smaller one is 10 feet long, 8 feet wide and 8 feet high. The ovens are fitted with Kinnear rolling doors and with cars of the usual type. The core room equipment was furnished by the Whiting Foundry Equipment Co., Harvey, Ill. The ovens are coke fired from the basement. The oven temperatures, which are maintained at approximately 400 degrees Fahr., are indicated by means of recording thermometers.

The cleaning room, which is located under the molding floor at the north

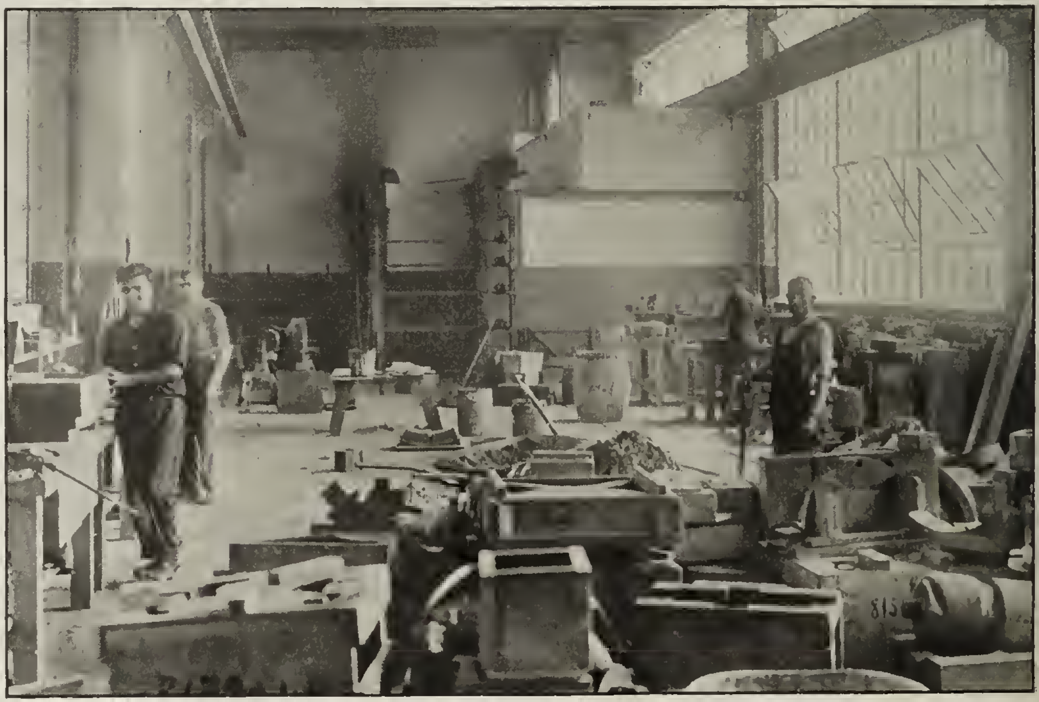


FIG. 8—A CORNER IN THE CORE ROOM

end of the building, is approximately 45 feet square. As previously described, the castings are dropped down to the cleaning room floor through a hatchway by means of the main traveling crane. In addition to grinding and chipping apparatus, the cleaning room equipment includes a 30 x 48-inch tumbling mill and a steel plate sand blast room. This room is ventilated by a 45-inch exhaust fan driven by a 7½-horsepower Westinghouse motor. The dust is collected in a 250-unit arrestor. A 1,200-pound, pressure-type sand tank is provided. The tumbling mill, which is driven by a 10-horsepower General Electric motor, is also connected to the dust-exhaust system.

A completely equipped laboratory occupies a portion of the charging floor. Its general arrangement is shown in Fig. 9. In addition to the customary chemical apparatus, the equipment includes balances, electric furnaces, etc. The laboratory is utilized for research work as well as for routine analyses. The room is 18 feet wide and 24 feet long.

The locker rooms on the mezzanine floor are provided with modern toilet facilities, running water, etc. Sanitary drinking fountains are placed at various points throughout the shop. These conveniences, together with the unusual lighting, heating and ventilating facilities, combine to make the shop unusually attractive from the workman's standpoint.

The average price of copper for 1916 showed a marked increase over that of the preceding year, being slightly above 27 cents per pound, compared with 17.4 cents in 1915.

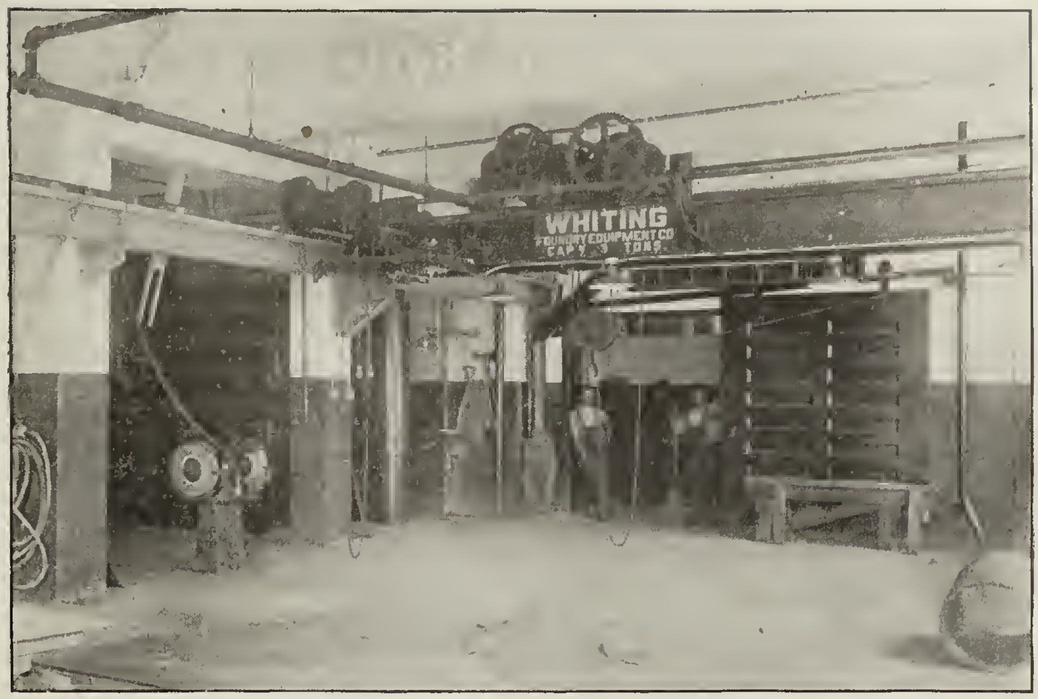


FIG. 10—FLOOR-OPERATED ELECTRIC CRANE IN CLEANING ROOM IN BASEMENT

To Reduce Combined Carbon

By W. J. Keep

Question:—I would like to know how to reduce the combined carbon in our mixtures. We desire iron of approximately the following composition: Silicon, 1.90 to 2 per cent; manganese, 0.55 to 0.65 per cent; phosphorus, 0.286 per cent; sulphur, 0.08 to 0.09 per cent, and combined carbon, 0.40 per cent. We are able to secure the above analysis with the exception of the combined carbon, which continues to run about 0.60 to 0.70 per cent. This mixture is being used for cylinder castings and is somewhat hard and at times the shrinkage is excessive. We use two grades of pig iron with scrap of the following compositions:

No. 1 pig.—Silicon, 2.46 per cent; manganese, 0.86 per cent; phosphorus, 0.315 per cent, and sulphur, 0.02 per cent.

No. 2 pig.—Silicon, 2.46 per cent; manganese, 0.75 per cent; phosphorus, 0.325 per cent, and sulphur, 0.018 per cent.

Return scrap.—Silicon, 1.70 per cent; manganese, 0.70 per cent; phosphorus, 0.43 per cent, and sulphur, 0.08 per cent.

We use 500 pounds each of No. 1 and No. 2 pig iron, 300 pounds of steel cuttings, and 200 pounds of return scrap. We are endeavoring to make good, machinable automobile cylinders.

Answer:—For automobile cylinders, the following analysis was recommended in a paper presented before the American Foundrymen's Association: Silicon, 1.75 to 2 per cent; sulphur, under 0.08 per cent; phosphorus, 0.40 to 0.50 per cent; manganese, 0.60 to 1 per cent; combined carbon, 0.55 to 0.65 per cent, and total carbon, 3 to 3.25 per cent. You will note, therefore, that your mixture is pretty close to the one suggested. However, you are using too high a percentage of steel scrap and it is altogether probable that your coke is of poor quality. The iron should not take up more than 0.03 per cent of sulphur in one remelting and your steel scrap should reduce it further. Also you will probably reduce the total carbon below 3 per cent by the steel addition. Purchase good coke and reduce your steel scrap to about 200 pounds and your combined carbon probably will be what you desire and your shrinkage also will be decreased. Your pig iron, as indicated by this analysis, is exceptionally good.

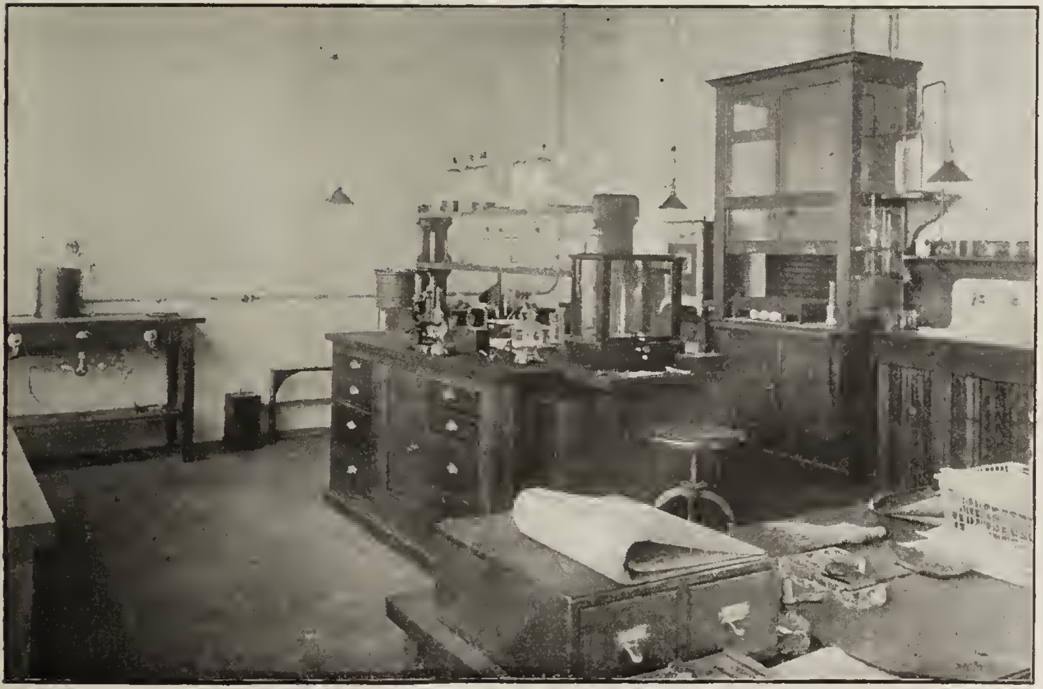


FIG. 9—THE LABORATORY IS EQUIPPED FOR RESEARCH WORK AS WELL AS ROUTINE ANALYSES

Pattern Shop and Foundry Organization

Good Foundry Management Depends on the Proper Organization of Each Department and the Maintenance of Harmonious Relations Between Them

By F M Perkins

THE organization of the pattern shop and foundry is a subject which presents wide possibilities for discussion and one upon which volumes could be written if one should attempt to cover all the many details of organization and management applicable to the various types of castings plants.

It may appear presumptuous to attempt, in a few pages, to cover this broad subject; therefore, let me admit now that only points which are essentially and fundamentally vital to the proper organization of a foundry and pattern shop will be considered. While in this apologetic mood perhaps I had better make one more confession; you will find nothing revolutionary, remarkable nor particularly new. My idea is simply to consider first principles and, from a common sense viewpoint of what is really essential, to point out those principles and to present, in an orderly and logical sequence, the salient points of which an efficient organization must take cognizance. It is hoped that the principles of organization so presented may be of some assistance as a general guide to those superintendents and managers engaged in or anticipating a reorganization or general housecleaning in the pattern and foundry departments.

While the intention is to deal primarily with the pattern shop and foundry some consideration must be taken of the relations of these two shops to the designing department and the machine shop to which departments they are, in certain ways, inseparably connected.

We accept as axiomatic the statement that there is no one organization which can be applied to all shops. The governing principles will be universally applicable, but the system itself, which is largely made up of men, methods and forms, must be worked out for each plant. Certain features can always be adopted, but the rigid structure of organization developed for particular conditions will not fit where conditions differ. Therefore, it is important for the manager developing his own system, to have clearly fixed in his mind a happy combination of first principles together with practical ways and means of applying them.

The business of producing finished castings may be broadly divided into four stages, as follows:

1.—Designing.
2.—Patternmaking.
3.—Founding.
4.—Machining.

These four stages leading up to the birth of a finished casting, are intimately related and extremely interdependent.

The whole idea of good management is concerned first, with the proper internal organization of each of the four departments dealing with the four stages of work, and second, with the establishment of proper relations and the securing of co-operation between the departments, so that each one does its own work, not only to its own best advantage, but also to the best advantage of succeeding departments. In the manufacture and machining of castings the influence of one department upon another is peculiarly marked. A casting is lost in the machine shop and the machinist blames the molder; the molder blames the patternmaker or machinist; the patternmaker blames the molder or the draftsman and the draftsman blames them all and the whole thing is soon resolved into the merry little game of *passing the buck* and the manager wastes an hour or two of valuable time endeavoring to locate the cause of the trouble and then, perhaps, fails.

Departments Must Cooperate

This sort of thing is not only expensive in time and material lost, but is disorganizing and hurtful morally. A good organization, by securing cooperation and establishing proper relations between departments, reduces the number of these unpleasant occurrences to a minimum.

The internal organization of the designing department is subject to wide variations in many of its features; there is one absolutely essential feature, however, the importance of which cannot be over-estimated, and that is, that the head designer or machinery draftsman, by whatever title he is known, shall have, either of his own knowledge or readily available, working information of patternmaking, molding and machining. This point is vital. It is not merely a theory or a platitude to be lightly passed over, but is absolutely identified with the over-all efficiency of the plant. Of course, in different plants, the extent to which the designer can influence the plant's efficiency varies. In a plant turning out a large variety of work the influence of design will be most largely felt; in plants turning out a standard line of work where design is, to a great extent, standardized, its influence will be lessened, but in all cases it is of the greatest importance.

Unfortunately, however, it is only the exceptional designer who has an accurate, practical knowledge of patternmaking, molding and machining in addition to his primary profession—designing and drafting. It is not to be expected that a man can master three or four trades and know them as well as the specialist in each. It is unusual for the average machinery draftsman to have spent as much as one year each in practical work in the pattern shop, foundry and machine shop. Hence it is entirely natural that he should know considerably less of these trades than the foremen who have spent years in learning them and who, in virtue of their position, presumably are exceptionally good men at their trades.

Therefore, it is important that the designer shall, in some way, be connected with the pattern shop, foundry and machine shop. The designer should have the benefit of the practical knowledge of the foremen of these shops to the end that the work in their shops may be simplified and costs reduced. The exact method of accomplishing this first step in cooperation is unimportant if the end to be gained is kept in view. One method would be for the designer and the three shop foremen concerned to meet for a half hour or so every morning to consider special points in connection with the design of new work. Another method which appeals to the writer as more direct and business-like is for the designer to send or take his rough or pencil plan to the foremen of the pattern, foundry and machine shops and interview them. A few minutes with each will usually suffice and time so spent will pay big dividends in the way of time and material saved in one or all of the shops concerned.

When the manager has solved to his satisfaction the problem of giving the designing section in a systematic way the benefit of the knowledge of his shop foremen, the next subject for his investigation will be the internal arrangement of the pattern shop and its connection with the foundry. The important points to be considered are:

1.—Equipment.
2.—Layout.
3.—Pattern storage and indexing.
4.—Assignment and routing of work.
5.—Transportation to and from foundry.

Equipment is necessarily dependent upon the class of work done. It is beyond the scope of this article to deal with the various kinds of equipment. The manager or superintendent with the help of the foreman should thoroughly study the needs of the shop in this respect by inspection of neighboring shops, reading the best trade magazines and other publications and by observation of the work done by the machines and tools installed. A systematic method of inspecting motors and delicate machines should be adopted to prevent loss of time by breakdowns. Saws, knives, lathe and other cutting tools should be ground regularly to insure good work and spare saws and knives of each size should be kept ready for replacing dull ones. Efficient safety devices should be installed on dangerous high speed machines and a first-aid kit kept in the foreman's office.

Planning Layout of Plant

The layout of the shop includes the arrangement of office, benches, machine and hand tools, pattern lumber, and usually a store room for patternmakers' supplies, such as nails, brads, screws, fillets, wax, glue, shellac, alcohol, putty, plaster of paris, sand paper, etc.

The main governing conditions are the location of the shop with reference to the foundry, the shape of the available floor space including interference of building columns, and the lighting.

As in all shops the objects to be attained are a continuous flow of work, non-interference of work and men, and accessibility of tools and material, producing a minimum of traveling about the shop.

In general it may be stated that benches should be standardized, that they should be lined up in an orderly manner to facilitate routing and inspection of work and that they should receive first consideration in the matter of lighting if there is any choice.

Machine tools should not be placed in one end of a long shop and benches in the other. It is usually a better arrangement to parallel them.

The pattern lumber storage should, if possible, be in a central location and stored in an accessible manner. Provision should be made for storing short ends in such a way as to make them easily looked over and readily available.

Order and Neatness

A patternmaker uses a greater variety of tools and materials than any other workman of the principal trades. For this reason order and neatness as time-savers in the use of tools and materials especially become the patternmaker and the pattern shop. Order and neatness should therefore be insisted upon. As an aid to this end, one or more boys usually can be profitably employed in providing the benches with nails, brads, dowels, etc., in returning short ends of pattern lumber to the bins, cleaning machines, and, if an exhaust system is not installed, dusting and sweeping.

With a soft pine board laid out to scale to represent the floor space and pieces of pasteboard also cut to scale to represent office, machines, benches, lumber storage and storeroom, the manager may spend many an interesting and profitable evening at home playing checkers with his shop. When the best possible combination has been decided upon it may be made up into a plan, which, if impracticable to have carried out at once, at least affords a sure guide for making changes from time to time and an eventual goal to be worked for, thereby eliminating expensive false moves.

If the number of patterns on hand exceeds several hundred a simple and efficient system of pattern storage and indexing is a necessity. With such a system and sufficient storage space the number of patterns that can be conveniently stored and indexed is practically unlimited; any one pattern wanted out of 100,000 can be located on two or three minutes' notice.

The method of storing patterns depends principally upon the available floor space. If possible the storage loft should be in the pattern shop building or adjacent to it. This not only facilitates handling, storing and indexing of patterns, but places them where they can be examined by the pattern shop foreman when it is desired to change an old pattern instead of making a new one.

The building should be fireproof and, if the pattern loft is extensive, it should be subdivided into fireproof compartments. It is also desirable that the pattern shelves should be of fireproof construction.

The method of indexing depends upon the number and variety of patterns to be dealt with and will suggest itself. The main feature to be considered is an alphabetical arrangement of index cards or of leading cards indicating groups of patterns of a similar kind so that the card of any one pattern may be found readily, first by looking under the sub-heading or group of similar patterns to which it belongs and then by identification within this group by name, size or number. Every pattern (and accompanying core boxes) should have a number. It is convenient to simply number the patterns consecutively as they are made and to keep a cross-index in a book so that any pattern may be identified by its number or the number on the casting.

Index Card

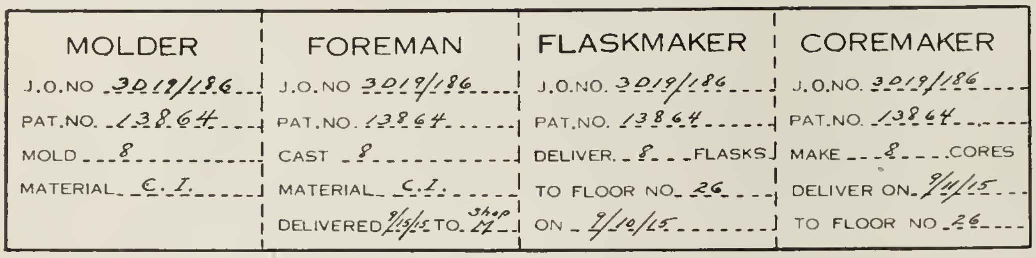
The index card should show the location of the pattern, the name of the casting, the number of the plan from which made, the number of the pattern, and the number of core boxes, if any. To this may be added if desired, the principal dimensions of the pattern, its cost, date and nature of alterations made, etc. If it is customary to ship patterns away for temporary use the index card provides a most convenient means of keeping a record of this. The central planning office or designing section should have a duplicate of the pattern shop card index or, in some other way, arrange to get ready information as to the patterns on hand, in order that patterns already made may not be duplicated or that advantage may be taken of patterns which, by slight alterations, may be used for the job on hand.

The most convenient method of issuing orders for patterns and castings is for the planning office or other office, by whatever name known, to consider the pattern shop and foundry as one shop; that is, to order the casting from the patternmaker. The reason for this is that it is not necessary to issue plans or detailed instructions as to dimensions, etc., to the foundry. These instructions are important for the pattern shop and when this shop has finished with them they are embodied in the pattern itself which is sent to the foundry. The important information for the foundryman is the number of castings to be made, the material and the desired date of completion.

The foreman molder and foreman patternmaker must pull together. Between these two friction often exists and this where *anti-friction* or teamwork is especially needed. The patternmaker must consult with the molder concerning many points. Much depends upon the personality and ability of these two men. Interested and honest co-operation on their part will promote the casting game wonderfully.

Transportation Between Pattern Shop and Foundry

Transportation between the pattern shop and foundry is usually susceptible of simple and satisfactory solution. The transportation may be considered satisfactory when it provides the shortest practicable route between the two shops, when it is frequent enough to avoid delays, when it guards against breakage or loss of small parts of patterns and is inexpensive. Patterns should be returned to the pattern shop as soon as the foundry has finished with them and, having been returned, should be stored at once in the pattern loft, being first indexed, if new patterns. As patterns are usually expensive every care should be taken to guard against loss, breakage and deterioration due to exposure to smoke, dampness and rough handling.



MOLDER	FOREMAN	FLASKMAKER	COREMAKER
J.O.NO 3019/186	J.O.NO 3019/186	J.O.NO. 3019/186	J.O.NO. 3019/186
PAT.NO. 13864	PAT.NO. 13864	PAT.NO. 13864	PAT.NO. 13864
MOLD 8	CAST 8	DELIVER. 8 FLASKS	MAKE 8 CORES
MATERIAL C.I.	MATERIAL C.I.	TO FLOOR NO. 26	DELIVER ON 9/11/15
	DELIVERED 9/15/15 TO Shop M	ON 9/10/15	TO FLOOR NO 26

TAG WHICH ACCOMPANIES EACH MOLDING JOB

The manager, having straightened out the internal affairs of his pattern shop and established its status with regard to its relations with the designing section and foundry, may now proceed to the work of getting acquainted with and reorganizing, if necessary, his foundry.

The work of the foundry embraces a multitude of diverse operations and details, but for the purpose of organization of the essential elements a consideration of the following five subjects will embrace everything vital to the foundry. The manager, once certain that these matters are working properly, may feel assured that his foundry is in good shape and a study of the more detailed operations may be taken up by him later. The five important points to be considered are:

1.—Equipment.
2.—Layout.
3.—Melting practice.
4.—Assignment and routing of work and material.
5.—Transportation.

The equipment of the foundry, to a greater degree even than that of the pattern shop, is a matter for special study and should include not only the question of new equipment but also that of getting the most out of the equipment on hand. Each item of equipment should be the subject of separate investigation and record as to performance and cost of upkeep. Poor or indifferent equipment well cared for and properly used is usually more efficient than expensive high grade equipment that is allowed to deteriorate unduly or to be used improperly. The more important items to look out for are cranes, cupolas, machines, air compressor, mills, tumblers, sprue cutters, flasks, and, if they can be considered equipment, molding and core sands. Many good brands of all kinds of equipment are on the market; in selecting new equipment the problem is, therefore, not so much the selecting of some first class article as the choosing of the article best suited to the peculiar needs of the foundry in question.

Only practical foundry experience or a mind trained to accurately size up machines and work methods can serve as a guide in the selection of new equipment. The more important consideration in established plants will be usually to get the equipment on hand in shape to work at its maximum efficiency.

Foundry Layout

The layout of the foundry, like the pattern shop, is influenced largely by local conditions such as size and shape of the building, available ground space adjacent to the foundry, and geographical location with respect to the pattern and machine shops.

A foundry layout is always a question of individual solution; no attempt can be made to even approximately lay down fixed rules to suit unknown conditions. A few general ideas or suggestions more or less applicable to all foundries may, however, prove helpful by suggesting lines of possible improvement.

If more than one kind of metal is cast; for example, gray iron, steel and brass, the molding space should be laid off into iron, steel and brass floors. In a combination foundry this is the first step toward simplifying routing, transportation and supervision and toward eliminating interference.

This step having been accomplished or decided upon the next logical move is to see that the cupolas are centrally or conveniently located with regard to the iron floor, the converter or steel crucibles near the steel floor and the brass furnaces or crucibles near the brass floor. This certainly appears very elementary and yet one cannot visit many foundries without finding this first principle of arrangement violated.

Arrangement of Storage Bins

The next step, which naturally follows, is to see that the flasks needed for the class of work on each floor are located conveniently to that floor and that the metals—iron, steel, copper, etc.—are located near the point where they are to be melted. Coal and coke for the crucibles, cupolas and core ovens should be stored near them.

Flasks usually receive the last consideration as to location after everything else is provided for. If the plant does a class of work calling for a large variety of flasks the matter of transporting them in and out of the foundry is considerable. The practice, too often seen—of leaving them piled up around the foundry floor until the molders have to fight their way through them, causes loss of time to the men and loss of floor space where floor space is often a matter of first importance. Therefore, an accessible and convenient location of flasks combined with an efficient means of carrying them to and from the floors is important.

If possible, the flaskmaker or repair man should be located with his little shop or tool equipment between the flask yard and the foundry so that flasks entering the foundry may have the cope bars put in and flasks leaving the foundry may be repaired.

The location of the core room, as far as possible, should be central, unless there is a coremaking department for each class of castings. A neat core storage arrangement and safe transportation to the floors are important. Core ovens should open into the core room and proper means should be provided for the orderly storage of core sands, core plates, wires, core boxes, flour, oil, molasses, plumbago, etc. The accumulation of old core boxes and cores and miscellaneous junk so often seen in the core room should not be permitted. The advantages of neatness and system apply to the core room as much as to any other department.

The cleaning room should be at the *outlet* or shipping end of the shop and easy and direct transportation from the molding floors to the cleaning room to the shipping room should be effected.

Special combination racks and bins for the storage of small equipment should be placed about the floor in several convenient locations. These racks are used for storing clamps, gaggers, wedges, gate-sticks, slings, nails, etc. The number and size of these articles used will suggest to any practical mind a convenient form of rack. All these items of one size are thus kept together and much time ordinarily spent in scratching around and looking for wedges, clamps, etc., of the right size will be eliminated. Molders are notoriously unsystematic and disorderly and the advantages of neatness and order can usually find great opportunities in the foundry. It is a good scheme to have a boy or two to do nothing but return gaggers, nails, core wires, etc., to their proper storage places.

Foundry Checkers

As with the pattern shop, the manager may play his game of *checkers* with the foundry, his *checker men* being the raw materials, iron, copper, coke, etc.; the cupolas, crucibles and furnaces; the flasks and patterns; the core room; the molding floors; the cleaning and shipping rooms. He may consider that he has won the game when his plant is so arranged that all these elements entering into the manufacture of a casting combine to produce a positive flow of work through the plant in one direction, without interference and with a minimum of movement of men and materials.

The melting practice is a subject too often left unnoticed on the part of the superintendent or manager who assumes that a knowledge of melting and mixing of metals is a detail demanding too much of his time to master. This, however, is not the case. The melting of iron and of the more common copper alloys is governed by certain principles with which he should familiarize himself. The manager, having once determined what melting practice is best for his melting equipment and what chemical and physical properties he wants for his various metals, is principally concerned with establishing a sure and systematic method of obtaining those results. To do this intelligently a general knowledge of the principles of good melting is necessary and familiarity with the practice of melting and the details of the melting equipment is highly desirable.

It is the opinion of the writer, supported by his experience as well as by the experience of many others, that the proper and rational method of cupola operation is that which has been pointed out by Dr. Richard Moldenke in several articles published in *The Foundry* during the last few years. The writer can do no better than refer the reader to an article by Dr. Moldenke in the December, 1912, number of *The Foundry*.

Cupola Operations

The general idea of cupola operation may be briefly summed up as follows:

For every cupola there is a melting zone where the temperature is greatest and combustion most efficient. In this zone iron can be melted more rapidly and more economically and produced hotter than at any other part of the cupola. The area and height above the tuyeres and the depth of this zone are dependent upon the volume of air delivered (which is a function of the tuyere area) and the area of the cupola. The pressure of the air blast is altogether unimportant provided there is only sufficient pressure to give a positive flow of air. If a cupola is properly designed and properly charged, five ounces of air will melt iron as rapidly and more economically than 15 ounces. Large tuyere areas and low blast pressures should be used. The ratio of tuyere area to cupola area should be about 1 to 3. The volume of air, not the pressure, is the important consideration.

The following may be unhesitatingly accepted on faith although it is contrary to practice in many shops. A very clear and more detailed explanation will be found in the foregoing reference.

Experience shows that in all cupolas, regardless of size, the first iron will appear at the spout in from eight to ten minutes after *blast on*, provided the cupola is in efficient condition and properly charged. Properly charged, as far as the time of first iron is concerned, means the proper height of bed. The proper height of bed depends upon the location of the melting zone and the location of the melting zone is fixed for constant tuyere and blower conditions. Therefore, to find the proper height of bed we experiment with various heights until we find that one which gives first iron at the spout in from eight to ten minutes. This height will fall between 16 inches and 28 inches above the tuyeres for all normal cupolas.

The next consideration is the amount of coke and iron to be placed in the charges. The depth of the melting zone is from 4 to 6 inches. Therefore, when the bed has burned down 4 to 6 inches below the melting zone a fresh split of coke should come down to maintain the bed at the proper height and keep the iron in the melting zone. Each split of coke, then, should be from 4 to 6 inches (say 5 inches) deep. Good coke will give a melting ratio of 1 to 10; the amount of iron to go in one charge then is 10 times the weight of 5 inches of coke measured for the diameter of the cupola in question. All succeeding charges should be exactly the same. The practice of making the first charge of iron from two to three times the size of the other charges is wrong in theory and uneconomical in practice.

Melting Non-Ferrous Metals

The melting of brasses, bronzes and other alloys is governed by certain principles, the most essential of which were summarized by the writer in an article on "Foundry Use of Non-Ferrous Scrap Metals" in the *Journal of American Society of Naval Engineers*, February, 1915.

1.—*Protection of the metal from oxidation during melting.* This is ordinarily accomplished mechanically by covering the bath with charcoal or by otherwise preventing the flame and air from coming in direct contact with the metal, as by the use of covered crucibles.

2.—*Deoxidation of the metal after melting.* Oxidation cannot be entirely prevented during melting. After being melted the metal can be deoxidized chemically to a certain extent by the addition of some substance having a greater affinity for oxygen than the alloy. One of the best agents for this purpose is from 0.5 to 0.75 per cent of phosphor tin. Phosphor copper is used when the metal to be deoxidized does not contain tin. It is a mistake to assume that the more phosphorus is used the cleaner the metal will be. If the proper amount is used it will take up the oxygen and pass off as gas and the metal will show barely a trace of phosphorus or none at all. If too much is used only that which combines with oxygen will pass off and the rest will remain in the metal and cause blow-holes.

3.—*Melting the metals in the inverse order of their fusibility and volatility*, in other words, melting that metal first which is the least volatile and has the highest melting point. There are a few metals which are more volatile than others having a lower melting point and, in order to reduce the melting loss, in such cases, volatility should be the first and fusibility the second consideration. Zinc is the most common example of this met with in foundry practice; it has a higher melting point than tin or lead, but is much more volatile than either and is added last.

4.—*Thorough mixture of the metal composing the alloy.* This is accomplished mechanically by means of a stirring rod used in the furnace or crucible and also in the ladle. As each new metal is added it should be thoroughly stirred as soon as it has run down. The last operation before pouring the mold should be to stir the metal. Defective metal can often be made perfectly good simply by remelting.

5.—*Pouring the metal at the proper temperature.* This is important but one of the most difficult points to control and one upon which more information is needed. If an efficient pyrometer is available a record may be kept of pouring temperatures and results and the proper temperature determined approximately. Metal should not be overheated and allowed to cool; it should be removed from the furnace or crucible and poured as soon as possible after reaching the proper temperature. In general, the brasses and bronzes should be poured hot and cooled quickly. One of the greatest causes of defective brass castings is pouring them cold. The melter's eye cannot compete with a pyrometer successfully.

6.—*Removal of dirt, dross and foreign matter by the use of fluxes.* The fluxing material—salt, borax or sal-ammoniac—is thrown upon the surface of the metal in the ladle and well stirred in. The resulting dross or slag which forms on the surface is then skimmed off.

The important point, after good melting practice has been established, is to standardize the mixtures and to institute a uniform method of making each one, thus insuring uniformity and reliability of product.

In the assignment and routing of work and material in the foundry, the idea to be kept in mind is the assembling at the proper time and place of the man, the pattern, the flask and the sand. Conditions vary, but the results remain the same. An idea of systematic work assignment can best be given by a brief description of a method which has been used by the writer.

The molding space was laid off in floors, each floor being numbered and marked. When a pattern was sent to the foundry it bore the tag shown in the illustration on page 50. The foreman patternmaker filled out the *foreman* stub and the *molder* stub. The *foreman* stub constituted the order on the foundry to manufacture the castings called for; the foundry foreman left the *molder* stub on the pattern, assigning the job to the individual molder by filling in the check number. He kept the *foreman* stub for his own file, filled in the *flaskmaker* and *coremaker* stubs and in two minutes his entire job was assigned. It only remained for the boy or clerk to deliver the pattern and core box with their stubs attached and the flaskmaker's stub. Modifications of this form will suggest themselves for the particular conditions in any foundry.

Foundry and Machine Shop Transportation

Transportation from the foundry to the machine shop, assembling room or shipping room should receive close attention. No rules can be laid down and the subject is only mentioned here to invite attention to its importance. A crane running from one shop to another is an ideal method. Failing in this, choice must be made between push cars, steam train, monorail, automobile trucks, etc., choice depending upon local conditions and the nature of the product.

The purchasing department, of which it is beyond the purpose of this paper to treat in detail, may next engage the attention of the manager. Having attained, by this time, a knowledge of what he wants he should look to the standardization of supplies and the establishment of specifications for raw materials.

In conclusion, it may be added that the element of personnel in the foundry, as in all other activities, is the most important single element affecting success or failure. The economic value of a contented force of men headed by a manager or superintendent whose personality begets confidence and inspires respect needs no elaboration on the part of the writer.

Systems, or routine methods of performing certain functions of management, once installed, have an unfortunate habit of falling into gradual disuse. To prevent this the manager should endeavor to enlist the interest of his subordinates in carrying out his wishes and should see that there is a clear chain of responsibility up to himself for the operation of every department and must, by frequent inspection, close questioning and observation, see that subordinates are held up to this high standard of responsibility.

Above all, remember that no system or short-cut has ever yet been devised that can afford a substitute for interest, good will and contentment and that the prime requisites for these are comfortable working conditions, encouragement, hope of advancement for efficient work and a square deal.

Remelting Shot Iron

By W. J. Keep

Question:—What is the best method of remelting shot iron recovered from a cinder mill? We have quite a large pile of it on hand and it continues to accumulate every day.

Answer:—You should use all of your own scrap each day. Since the furnaces in the vicinity of your plant produce iron somewhat high in silicon, you should obtain a supply of this metal, containing 4 or 5 per cent silicon, and a sufficient amount of this should be added, with scrap, to increase the silicon to 2.75 per cent or higher. Then you can add shot iron which will serve practically the same purpose as pig iron. You should shovel enough of this shot iron on each charge to use up what you make each day. Unfortunately, you do not give the size of your cupola. If it is small, there is danger of bridging if you use too large a quantity of this shot iron. Make the last charge, when the cupola is hottest, all shot iron with the exception of the high silicon iron used along with it. You can always put some shot on the cupola bottom before laying the wood and the first iron down will melt it. You can pour the first ladles into work which is not very particular if the metal happens to be on the dull side.

Lead began the year 1916 at New York with a price of 5.5 cents per pound and rose to 8 cents early in April, which was the maximum figure. A long decline carried the price down to 5.95 cents in the early part of August. Another rise reached 7 cents about the middle of September, after which the price remained stationary until early in December, when it advanced to 7.5 cents, and it closed the year at about that figure.

THE FOUNDRY DATA SHEET, FEBRUARY, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

GRINDING WHEEL STANDARDS

DIMENSIONS OF TAPERED FLANGES AND TAPERED WHEELS WHERE HOODS ARE NOT USED

From Safety Code Approved by Abrasive Wheel Manufacturers

Diam. of Wheel in Inches	A	B	C	D	E	F
6	0	1	3	⅜	2	⅜
8	0	1	5	⅜	3½	⅜
10	0	2	6	½	4	½
12	4	4½	6	⅝	4	⅝
14	4	4½	8	⅝	5½	¾
16	4	6	10	⅝	7	⅞
18	4	6	12	¾	8	1
20	4	6	14	¾	9	1
22	4	6	16	¾	10½	1⅛
24	4	6	18	¾	12	1⅛
26	4	6	20	¾	13½	1⅛
28	4	6	22	⅞	14½	1¼
30	4	6	24	⅞	16	1¼

A—Maximum flat spot at center of flange.
B—Flat spot at center of wheel.
C—Minimum diameter of flange.
D—Minimum thickness of flange at bore.
E—Minimum diameter of recess in taper flanges.
F—Minimum thickness of each flange for single taper at bore.

MINIMUM SIZES OF MACHINE SPINDLES IN INCHES FOR VARIOUS DIAMETERS AND THICKNESSES OF GRINDING WHEELS

From Safety Code Approved by Abrasive Wheel Manufacturers

Diameter in Inches	Thickness of Wheel in Inches																		
	¼	⅜	½	⅝	¾	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3¼	3½	4	4½	5
6	½	½	½	½	½	½	⅝	⅝	¾	¾	¾	¾	¾	¾	¾	¾	1	1	1
7	½	½	½	½	⅝	⅝	⅝	¾	¾	¾	¾	¾	¾	1	1	1	1	1	1
8	⅝	⅝	⅝	⅝	⅝	⅝	¾	¾	¾	1	1	1	1	1	1	1	1¼	1¼	1¼
9	⅝	⅝	⅝	⅝	¾	¾	¾	¾	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼
10	¾	¾	¾	¾	¾	¾	¾	¾	1	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½
12	¾	¾	¾	¾	¾	1	1	1	1	1	1	1¼	1¼	1¼	1¼	1¼	1½	1½	1½
14	⅞	⅞	⅞	⅞	1	1	1¼	1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1½
16					1¼	1¼	1¼	1¼	1¼	1¼	1½	1½	1½	1½	1½	1¾	1¾	1¾	1¾
18					1¼	1¼	1¼	1½	1½	1½	1½	1½	1½	1½	1¾	1¾	1¾	1⅞	1⅞
20						1½	1½	1½	1½	1½	1½	1½	1¾	1¾	1¾	1⅞	1⅞	1⅞	1⅞
24						1½	1½	1½	1¾	1¾	1¾	1¾	1¾	1¾	2	2	2	2	2
26							1½	1½	1¾	1¾	1¾	1¾	2	2	2	2	2¼	2¼	2¼
30								1¾	1¾	2	2	2	2	2	2¼	2¼	2½	2½	2½
36									2	2¼	2¼	2¼	2½	2½	2½	2¾	2¾	3	3

The Foundry, Data Sheet No. 227, February, 1917

GRINDING WHEEL STANDARDS

REVOLUTIONS PER MINUTE FOR VARIOUS SIZES OF GRINDING WHEELS TO GIVE PERIPHERAL SPEED IN FEET PER MINUTE AS INDICATED

From Safety Code Approved by Abrasive Wheel Manufacturers

Diameter of Wheel in Inches	4,000	4,500	5,000	5,500	6,000	6,500
1	15,279	17,200	19,099	21,000	22,918	24,850
2	7,639	8,590	9,549	10,500	11,459	12,420
3	5,093	5,725	6,366	7,000	7,639	8,270
4	3,820	4,295	4,775	5,250	5,730	6,205
5	3,056	3,440	3,820	4,200	4,584	4,970
6	2,546	2,865	3,183	3,500	3,820	4,140
7	2,183	2,455	2,728	3,000	3,274	3,550
8	1,910	2,150	2,387	2,635	2,865	3,100
10	1,528	1,720	1,910	2,100	2,292	2,485
12	1,273	1,453	1,592	1,750	1,910	2,070
14	1,091	1,228	1,364	1,500	1,637	1,773
16	955	1,075	1,194	1,314	1,432	1,552
18	849	957	1,061	1,167	1,273	1,380
20	764	860	955	1,050	1,146	1,241
22	694	782	868	952	1,042	1,128
24	637	716	796	876	955	1,035
26	586	661	733	809	879	955
28	546	614	683	749	819	887
30	509	573	637	700	764	827
32	477	537	596	657	716	776
34	449	506	561	618	674	730
36	424	477	531	534	637	689
38	402	453	503	553	603	653
40	382	430	478	525	573	621
42	364	409	455	500	546	591
44	347	391	434	477	521	564
46	332	374	415	456	498	539
48	318	358	397	438	477	517
50	306	344	383	420	459	497
52	294	331	369	404	441	487
54	283	318	354	389	425	459
56	273	307	341	366	410	443
58	264	296	330	354	396	428
60	255	277	319	350	383	414

The Foundry, Data Sheet No. 228, February, 1917

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

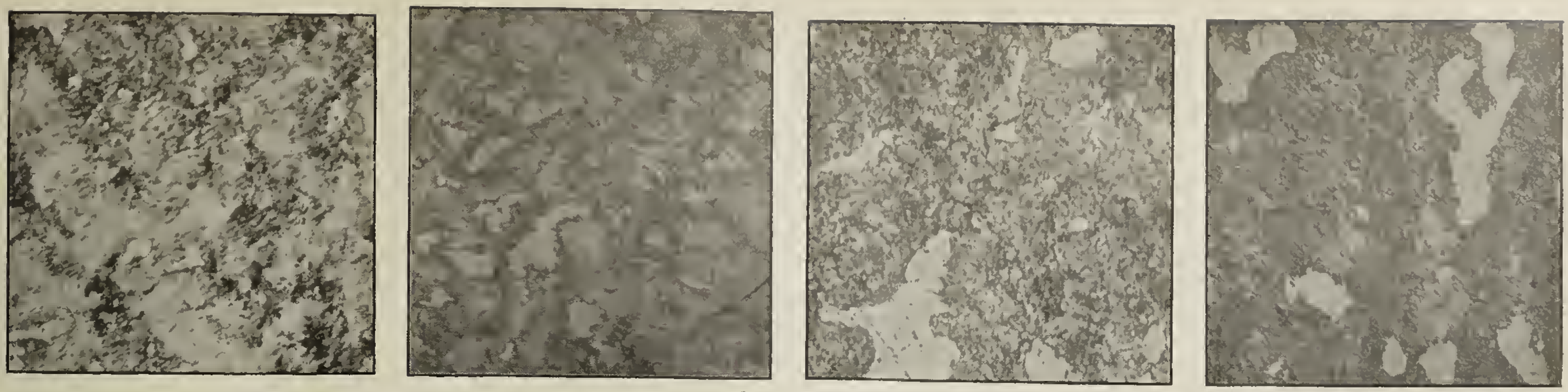


Fig. 1—Semi-steel containing 50 per cent steel—Fig. 2—Piston containing 25 per cent steel—Fig. 3—Sample containing 30 per cent steel—Fig. 4—Punch containing 40 per cent steel. All microphotographs are magnified 200 diameters except Fig. 29, which is magnified 25 diameters, and Fig. 30, which is magnified 400 diameters

The Properties of Semi-Steel Castings

By David McLain

WHILE it is true that semi-steel has not been recognized in iron and steel nomenclature, still, as it ranks among the most valuable products of the gray iron foundry, it should be accorded proper recognition and standard chemical specifications covering the different classes of castings should be clearly defined. Admittedly it is rather unfortunate that any cast metal containing from 3 to 10 per cent steel is designated as semi-steel, and in this particular we are in hearty agreement with those who consider that semi-steel is a misnomer.

Our contention always has been that no metal could be defined as semi-steel unless it contained from 25 to 50 per cent steel, and even the reputation of this metal has suffered to some extent from those who offer a product as semi-steel which is not even a good gray iron.

Although there have been large casting losses in the past by those who knew but little of the science of melting steel in cupola mixtures, still I believe the literature and papers published on semi-steel during the past few years have started many foundrymen thinking along right lines. More than 1,000,000 tons of semi-steel were made last year and every foundryman sooner or later must be able to make real semi-steel as engineers are continually demanding stronger metal and lighter sections for castings that must stand higher tests.

Historical Facts

The aim of this discussion is to place before the foundry trade in general, a few plain truths about semi-steel. Many of these statements deal with historical facts dating back 15 years. Many points set forth herein may be opposed, and even ridiculed.

For 50 years or more, foundrymen have added steel to iron in the ladle, while comparatively few melted slight amounts of steel in the cupola, but up to 1902 or 1903 no record could be found of any man having used large percentages of steel in castings of light section. Years ago foundrymen witnessed the charging of steel in the cupola and yet remarked: "That is all right; it may be possible in the steel foundry, but you never could do it in the iron foundry."

In 1899, A. Christensen, the inventor of the street railway air-brake, built a foundry to make gray iron, steel and brass castings. One pattern in particular, a cylinder head, had proved very difficult as the walls were only 5/16-inch section, while they were hydraulically tested to 200 pounds per square inch. In those days other engineers allowed one inch and more section for 200 pounds pressure, but Mr. Christensen saw the light in advance. It was a great advantage to the mechanical world that he did, as it was only a few years later that the automobile industry started in earnest. Today, it is truly wonderful when it is known that some cylinders with only 5/32-inch sections are being made with 10 to 20 per cent steel and tested to 200 pounds.

At that time the losses on the cylinder head castings were exceedingly heavy, so much so, that every foundry making them sustained large financial reverses. Investigation proved that almost every conceivable known mixture had been tried out by foundrymen having good reputations on this

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A paper read at the Cleveland meeting of the American Foundrymen's Association, September, 1916.

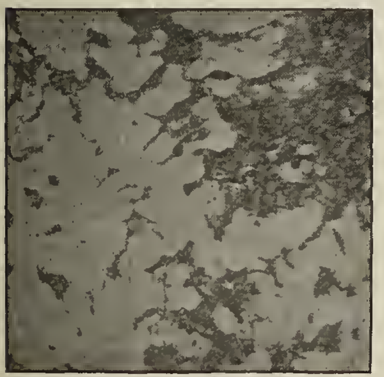


FIG. 5 — THIN EDGE OF PULLEY CONTAINING 40 PER CENT STEEL

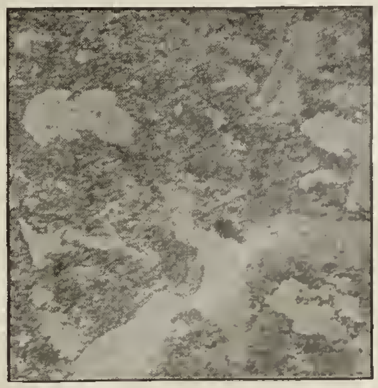


FIG. 6—SAMPLE CONTAINING 30 PER CENT STEEL

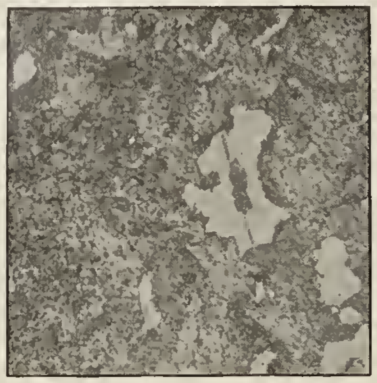


FIG. 7—ANOTHER SAMPLE CONTAINING 30 PER CENT STEEL

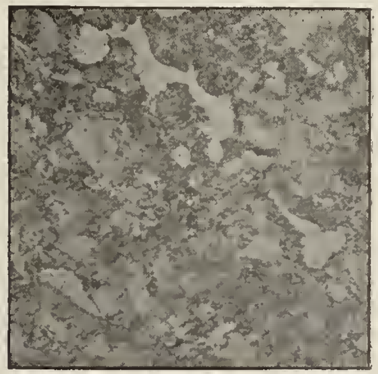


FIG. 8 — PACKING RING CONTAINING 30 PER CENT STEEL

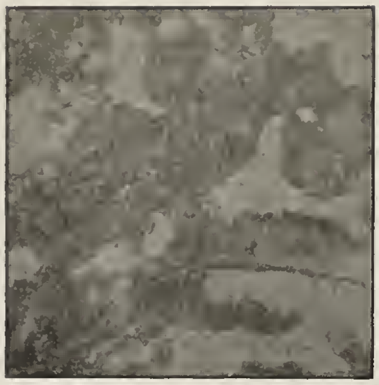


FIG. 9—GRAY IRON CYLINDER

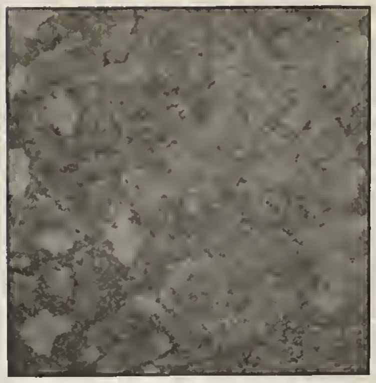


FIG. 10—SEMI-STEEL CONTAINING 0.75 PER CENT COMBINED CARBON

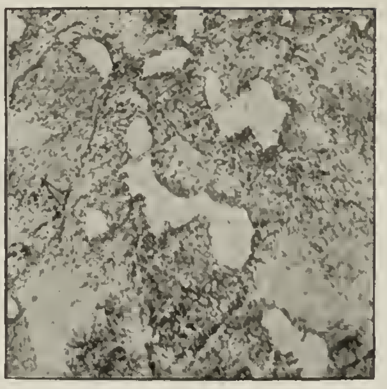


FIG. 11—PACKING RING; 30 PER CENT STEEL, 20 PER CENT SCRAP AND 50 PER CENT PIG IRON

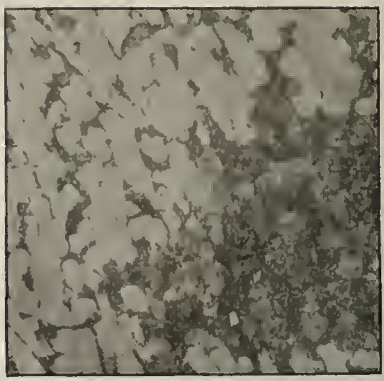


FIG. 12—CHILLED MOLD BOARD; 73 PER CENT OF METAL CHILLED

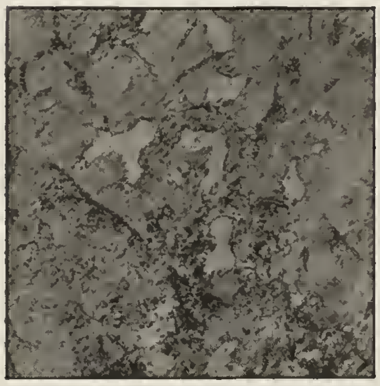


FIG. 13—SPECIMEN WITH 15 PER CENT STEEL

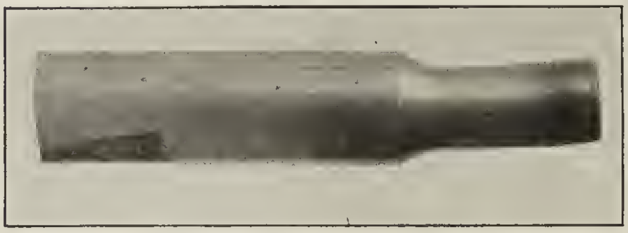


FIG. 14—REPRODUCTION OF ORDINARY PHOTOGRAPH SHOWING THAT SEMI-STEEL WILL STAND SLIGHT BENDING WITHOUT FRACTURE, DUE TO SMALL NUMBER OF GRAPHITIC CARBON FLAKES

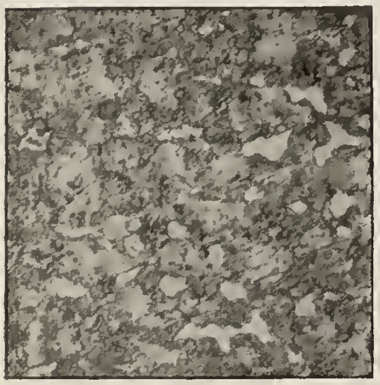


FIG. 15—AIR MIXER CASTING CONTAINING 30 PER CENT STEEL

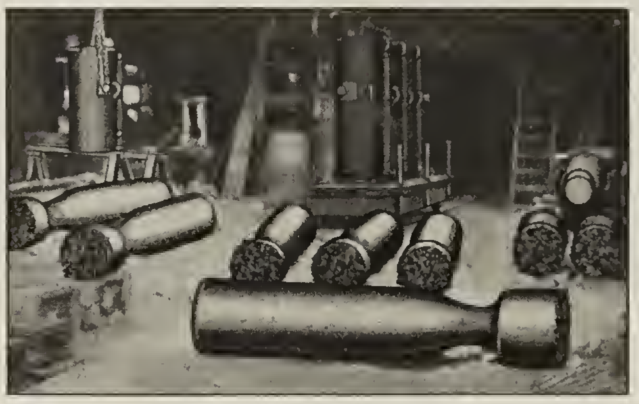


FIG. 16—SEMI-STEEL SHELL CASTINGS WITH SHRINK HEADS ATTACHED

class of work. It was a serious matter for Mr. Christensen and his associates, as they had large orders for air-brakes but were unable to secure satisfactory castings. After a long series of experiments, it was finally decided to drop gray iron and use steel scrap. We sought expert advice and personal service from those successful in using steel in heavy sections. After 10 weeks' experimenting the experts finally claimed the section should be increased, but Mr. Christensen would not accede to their wishes. Foundrymen advised that the pattern should be changed, but he would not listen to it, as he claimed: "When the metal was right, the castings were good." Later developments proved that he was correct.

From the start it was believed that steel scrap in the mixture would enable us to close the grain of the metal, but the great danger was that the metal would be too low in carbon, as all leading authorities claimed that "steel reduces carbon". Now as carbon must be high if sections are thin, apparently steel was not the right material to use, unless it was possible to absorb carbon from the fuel.

All textbooks, whether by technical or practical men, maintained that steel reduced carbon, that it was not a good thing to use as it caused "hard spots" that "a higher melting temperature was necessary," etc. Even today, the claim that steel melts first puzzles some chemists, metallurgists and others, who evidently do not take into consideration that steel has a great affinity for the elements and absorbs a large quantity of carbon from the fuel.

Those familiar with laboratory experiments know that if steel is added to gray iron mixtures, and melted in a crucible, the total carbon will be reduced. They also know that when steel alone is melted in a crucible it requires a higher temperature to melt it than the mixture of steel and gray iron. When steel is mixed with gray iron and melted *in a crucible* a slight loss will occur by oxidation and the carbon will increase somewhat, due to the absorption of this element from the pot. The total carbon, as calculated, in the iron will remain practically the same, but as the steel content of the mixture will add to the total weight of the resultant metal without a corresponding gain in carbon, the total carbon of course will be less than if all iron had been used. That condition, however, does not exist when melting steel scientifically in the cupola. If steel only is melted in a crucible, the chemist is quite right in his contention that steel requires a higher temperature than gray iron, but the same conditions are not met with in melting iron or steel in a cupola.

Cupola-Melted Steel

When melting steel with cupola mixtures, high carbon coke is used for fuel. Coke, of course, also can be used in crucible melting, but in this practice the metal does not come in contact with the fuel and therefore it does not absorb carbon from it. On the other hand, steel melted in the cupola comes in intimate contact with the fuel and owing to the very low percentages of the different elements in the steel, it has a strong affinity for them, particularly carbon. Consequently when the steel is heated to redness, it begins to absorb carbon and when the steel and fuel both become incandescent, the steel becomes saturated with carbon. In this state it is not steel as we know it commercially, but it is a high *carbon metal.* As the carbon increases, the melting point of the steel decreases until the temperature at which it will melt is lower than the temperature of the cupola.

Now this result was not obtained simply by charging iron and steel scrap into the cupola, but was the result of much research work. When it was first suggested to the melter that we try to melt steel in the cupola, he was horrified. He pointed out the harmful results following the use of only a few handfuls of steel and even went so far as to state a "spike in a piece of railroad tie" nearly spoiled a whole heat. Today, we know of firms who want to make semi-steel, and would if it were not for such stories.

Steel will not stand a cutting flame, but must be melted by a mild flame. The reason is quite simple. The carbon and silicon in steel are very low. The carbon ranges from 0.15 to 0.30 per cent in mild steel and the silicon about the same. When this metal has been heated and is about ready to melt, it will melt naturally, as soon as it reaches the proper temperature, which should be obtained by a mild blast. But if high blast is used, the cutting or oxidizing flame will cause excessive oxidation.

Carbon, silicon and manganese are burned out of the pig in the converter process of making steel, and it is a very simple process until the metal is nearly free of the elements, then the operator must exercise the greatest precaution in order to shut off the blast and turn down the vessel at the proper moment, for the metal at this time may be oxidized in a few minutes and the whole heat lost. When it is understood that during this process all graphitic carbon in the pig is converted to combined carbon in a few minutes by excessive blast is it any wonder that the use of steel in cupola mixtures does not produce the best results? The traditions of cupola practice were thicker than the walls of the cupola itself and it was necessary to replace these traditions with firmly established facts.

The false claim that more coke is required to melt steel than iron was made in those days, just as it is today, by some men not well versed in the fine points of the foundry business. Granting that you are an expert melter of iron and steel, still the best metal, the real semi-steel, cannot be made unless you mix iron with brains and the proper percentages of the elements, particularly manganese, as this is very important. As proof of the contention that less coke is required when melting steel, a few records made by progressive American foundrymen are shown in the table on page 57.

When melting 30 tons per day with coke at $6 per ton, and the melting ratio is increased from 7 to 1 to 10 to 1, a saving of $2,310 per year, equal to interest at 6 per cent on $38,500 is realized.

Iron, steel and manganese have a great affinity for sulphur, but as man-

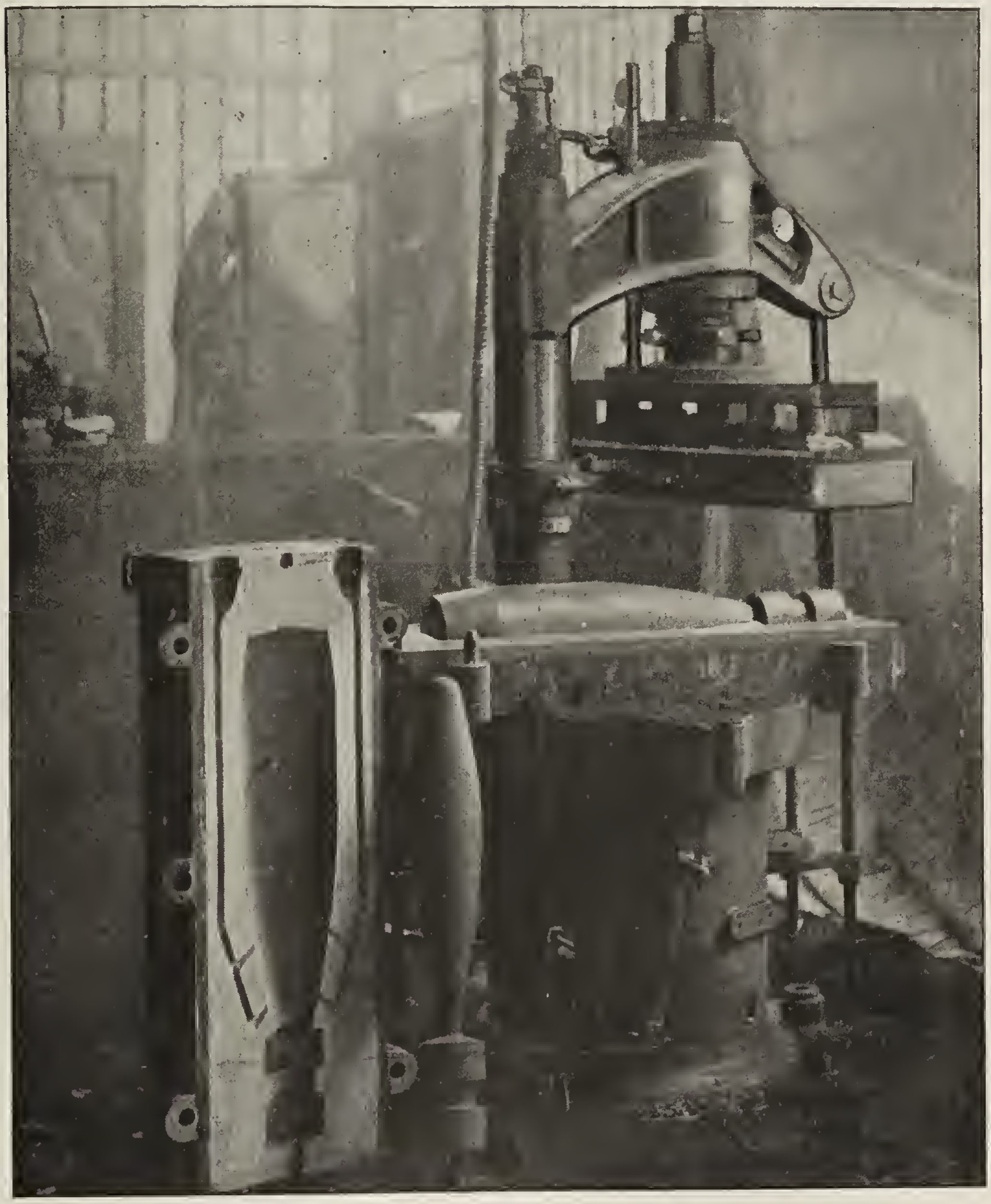


FIG. 17—ENGLISH PROJECTILE MOLDING MACHINE

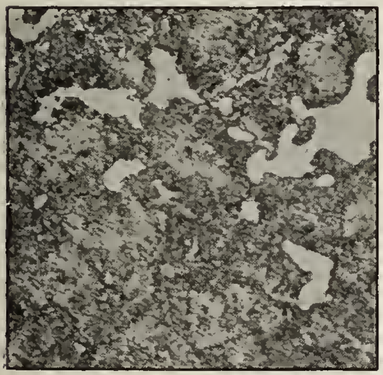


FIG. 18 — BUSHING CONTAINING 50 PER CENT STEEL

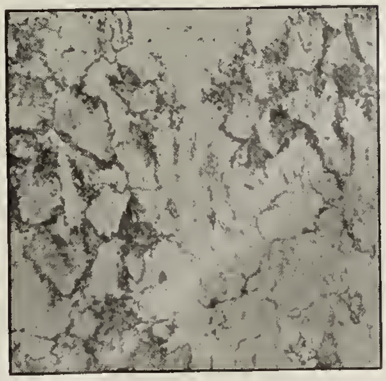


FIG. 19—BORE OF CYLINDER CONTAINING 25 PER CENT STEEL

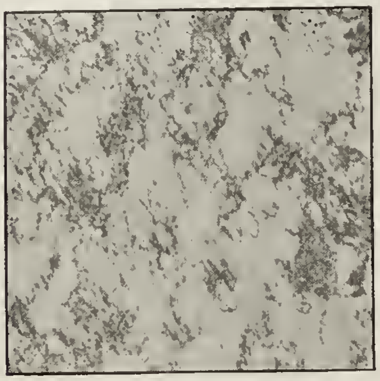


FIG. 20—SOFT SEMI-STEEL HARDNESS NUMBER 149

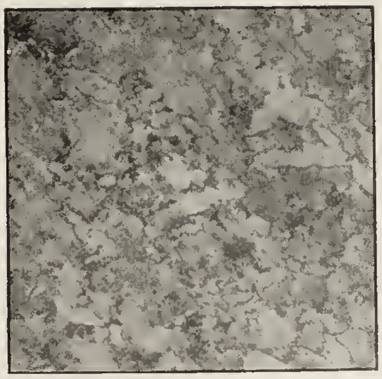


FIG. 21 — CASTING CONTAINING 30 PER CENT STEEL

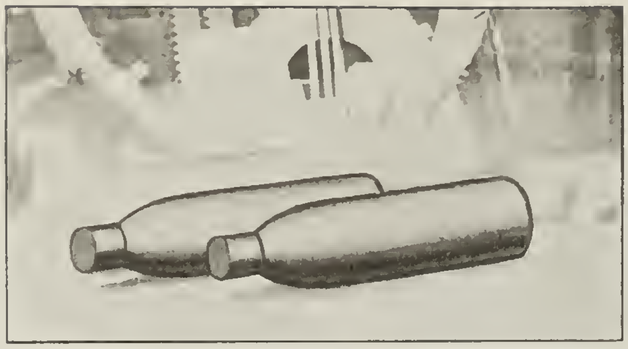


FIG. 22 — FINISHED SEMI-STEEL SHELL CASTINGS — THESE ARE SIMILAR TO THOSE SHOWN IN FIG. 16, THE RISERS HAVING BEEN CUT OFF

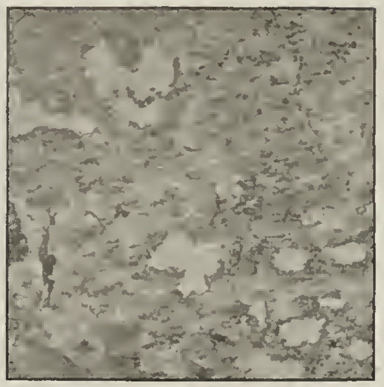


FIG. 23—SEMI-STEEL GEAR BLANK, 33.3 PER CENT STEEL

ganese has more of an affinity for oxygen than for iron, it has a tendency to leave the iron and will attract a percentage of sulphur, forming a manganese sulphide, some of which passes off in the slag. The amount of sulphur expelled from the metal will depend on the amount of manganese, the nature of the slag-forming elements, and the temperature at which the metal is melted. If both manganese and sulphur are high in the casting, have no fear of the sulphur, it will be neutralized by the manganese.

It was impossible to secure any reliable data on the percentage of manganese which should be used and as our local blast furnace made no pig with more than 0.70 to 1.00 per cent manganese, a few tons of 80 per cent ferro-manganese in lump form was purchased. This was added to the charge going into the cupola. The resultant metal enabled us to make the castings that Mr. Christensen desired, with only 1 to 3 per cent loss and our later experiments proved that steel scrap intelligently used was beneficial in all mixtures. Even 10 per cent increases the transverse strength of light castings from 25 to 35 per cent.

A concern in Michigan wanted stronger castings, but did not care to increase section nor weight, so under our guidance the company began using waste steel clippings with an increase in strength with only 10 per cent steel. The gray iron analyzed as follows: Silicon, 2.30 to 2.50 per cent; sulphur, 0.08 to 0.09 per cent; phosphorus, 0.75 to 0.85 per cent; manganese, 0.30 to 0.50 per cent. With 10 per cent steel the metal contained from 2.10 to 2.30 per cent silicon, 0.07 to 0.09 per cent sulphur, 0.60 to 0.70 per cent phosphorus, and 0.55 to 0.70 per cent manganese.

The strength tests were as follows:

	Transverse strength, Average.	Minimum.	Maximum.
Gray iron, lbs......	2,252	2,180	2,310
10 per cent steel, lbs.	2,900	2,760	3,020
Percentages in favor of 10 per cent st'l	28.7	26.6	30.7

Semi-steel is made in the same cupola with regular gray iron mixtures. No extra coke, special appliances, fluxes or new equipment are necessary. It is made in the same heat with other mixtures. It may be melted in the early part of a heat—in the middle or last part of your regular heat. Or you may begin with 30 to 40 per cent steel on the bed, run as much of this grade as is required and then follow with 20 to 25 per cent steel. Steel scrap should never be added to a ladle of molten metal, as numerous tests have proved that many imperfections in castings are traceable to this practice. A higher temperature is obtained in the cupola than in the ladle and all gases are liberated in the cupola and go up the stack. This is not so when adding steel to the ladle, as the temperature of the metal is considerably reduced when steel or other cold material is added. Generally when steel is added to the ladle, these gases are liberated in the castings and we find hard spots, blow holes, etc. No more coke is required to melt semi-steel than gray iron. In fact, scientific melting has taught melters to bring down hot iron with less fuel than formerly, although they are now using 20 to 50 per cent steel.

As it is 25 to 60 per cent stronger than gray iron, semi-steel may be of lighter section, hence it allows a reduction in weight by a reduction in section, making a big saving on metal. As a slight addition of steel has a very noticeable effect on the strength of metal for light castings, this has led many to assume that if a larger amount of steel is used, the metal would replace malleable iron. This is a mistake, and competent investigators never have contended that unannealed semi-steel should replace light malleable castings.

Some foundrymen who were making cupola malleable iron used malleable pig iron and investigation proved that with a percentage of this pig, large amounts of the return and steel scrap could be melted and after being properly annealed, could be twisted and bent cold. A tensile strength of 55,000 to 65,000 pounds per square inch could be obtained. The metal is white before being annealed, and as the annealing required from 10 days to two weeks, it was impossible to ship castings in less than three to five weeks from date of order. This process has been all but abandoned by those who formerly followed it, as it was a heart-breaking job at the best. The melting ratio was very low; the losses were very heavy; the long

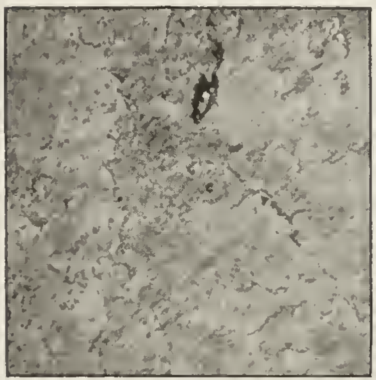


FIG. 24—SEMI-STEEL TEST BAR, TRANSVERSE STRENGTH 3,460 POUNDS

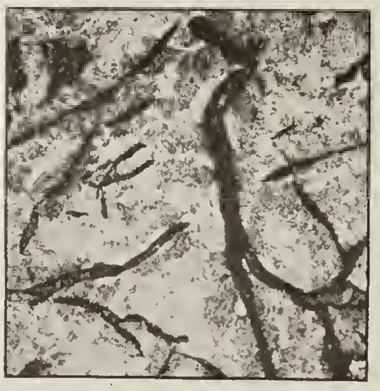


FIG. 25. — SPECIMEN OF GRAY IRON SHOWING GRAPHITIC CARBON

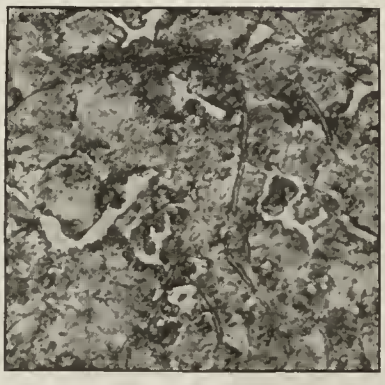


FIG. 26 — STRUCTURE OF LARGE PISTON CONTAINING 35 PER CENT STEEL

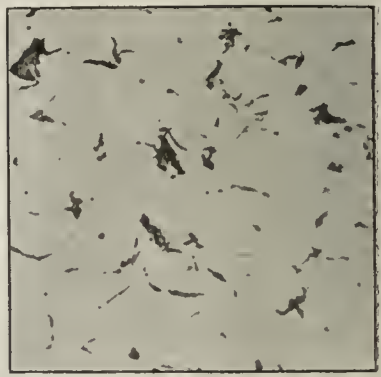


FIG. 27 — STRUCTURE OF SEMI-STEEL PUNCH, UNETCHED

Savings Which Have Been Effected in the Use of Coke

Daily tonnage.	Melting ratio.	Pounds coke required.	Daily saving pounds.	Yearly saving tons.	Saved per year on coke at		
					$5.	$6.	$7.
5	6 to 1	1,666					
	increase to						
	8 to 1	1,250	416	62	$ 310	$ 372	$ 434
15	6 to 1	5,000					
	increase to						
	9 to 1	3,333	1,667	250	1,250	1,500	1,750
30	7 to 1	8,571					
	increase to						
	10 to 1	6,000	2,571	385	1,925	2,310	2,695

annealing period was very discouraging, and if it were not for the bending tests, good semi-steel is preferable. The buyers thought it was steel, although many steelmakers advised them it was not steel. In fact, this material is really an annealed semi-steel.

Success With Steel Castings

Semi-steel is believed to be a great heat and acid resisting metal, because the metal is purer than gray iron. In recent fire tests of gray iron and semi-steel castings, to learn which is preferable, the gray iron lost 34 per cent by weight, while the semi-steel only lost 9 per cent. Even the despised grate bar is in a higher class than formerly, and railroads are eager for semi-steel grate bars, as tests have demonstrated that one set of semi-steel grate bars stands up better than three sets of gray iron bars. Gears and gear blanks made of semi-steel frequently will outwear steel gears. The high graphitic carbon in semi-steel acts as a lubricant, a feature not possible in steel castings. Many concerns who formerly made all their gears of steel are now making them of semi-steel. Acid castings, air, gas, water and steam engine castings, ammonia fittings, crane wheels, cross heads, gears, gear blanks, grate bars, glass house molds, jig castings, lathe beds, locomotive parts, machinery castings, diesel engine parts and valves, are improved when 30 per cent steel or more is used.

Fig. 25 is a micrograph of gray iron in which the large black carbon flakes may be seen. These flakes break up the structure of the metal, thus making it brittle and weak. The gray substance is carbon, combined with iron, forming steel, while the white is iron. The analysis is as follows: Graphitic carbon, 3.15 per cent; combined carbon, 0.15 per cent; silicon, 1.85 per cent; sulphur, 0.098 per cent; phosphorus, 0.402 per cent; manganese, 0.50 per cent. Fig. 9 is a specimen from a small gas engine cylinder made of gray iron. The manager of the foundry did not believe in the use of steel, but when the firm became converted he graciously consented to follow instructions and in a few weeks the loss was reduced to 2 and 3 per cent as against 20 and 30 per cent previously. Fig. 26 is a sample of semi-steel in which the graphitic carbon flakes are exceedingly small. The gray constituent is steel and the small white particles are ferrite or iron.

The writer believes the following classifications, with analyses, have proved best by actual test for semi-steel castings: Automobile cylinders, pistons and other light castings, 3/16-inch to ⅜-inch section with 10 to 20 per cent steel; silicon, 1.90 to 2.25 per cent; sulphur, 0.07 to 0.1 per cent; phosphorus, 0.35 to 0.55 per cent; manganese, 0.65 to 1.00 per cent. Packing rings, gas engine cylinders and automobile cylinders, ⅜-inch to ⅝-inch sections, with 15 to 25 per cent steel, silicon, 1.65 to 2.00 per cent; sulphur, 0.07 to 0.1 per cent; phosphorus, 0.35 to 0.55 per cent; and manganese, ranging from 0.65 to 1.00 per cent.

Fig. 2 is a micrograph of a specimen from a light gas engine piston. Figs. 8 and 11 are packing rings; Figs. 13, 19, 20 and 21 are cylinders; Fig. 15 is a gas and air mixer with 2.02 per cent manganese; Fig. 12 is a piece of chilled mold board, with 20 per cent steel; Fig. 3 is a specimen containing 30 per cent steel; Fig. 4 is a specimen containing 40 per cent steel; Fig. 7 is a specimen containing 30 per cent steel; Fig. 5 is a specimen containing 40 per cent steel; Fig. 18 is a specimen containing 50 per cent steel; Fig. 1 is a specimen containing 50 per cent steel; Fig. 24 is a specimen containing 40 per cent steel.

While both large and small projectiles are being made of semi-steel, technical men will hardly credit this statement. Fig. 16 shows several 12-inch projectiles which weigh 1,200 pounds net, and 1,600 pounds gross. Thousands of these have been made in America. Fig. 22 shows the same projectiles with the risers turned off. They are shipped in this form and are finished by the purchaser. Fig. 17 shows a molding machine used in making small projectiles. The pattern, core and one-half of a mold may be seen.

Hardening Semi-steel

An eastern firm objected to the high cost of the die steel used in its forge shop and some one suggested semi-steel. The foundry superintendent was called on and he agreed to make some semi-steel bars, which he thought could be hardened. They first tried it on a few punches for hot work, but it was either too soft or too hard, until they hit on the right process of hardening. The writer

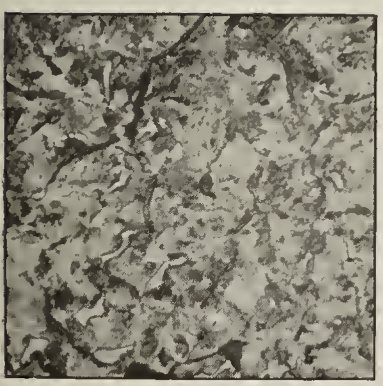


FIG. 28—STRUCTURE OF SEMI-STEEL PUNCH, ETCHED

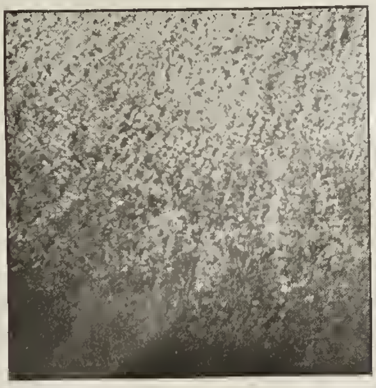


FIG. 29—STRUCTURE OF PUNCH NEAR SURFACE OF METAL

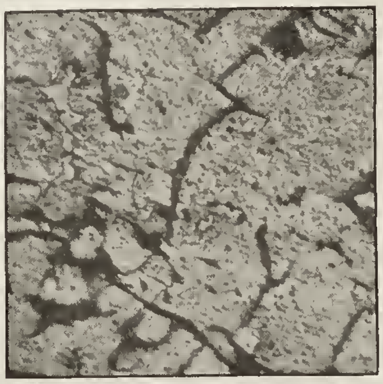


FIG. 30—STRUCTURE OF BRITTLE PUNCH

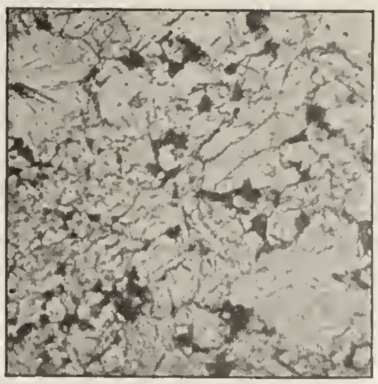


FIG. 31—MICROGRAPH OF A SEMI-STEEL TEST BAR

does not claim that semi-steel will replace tool steel, but is merely reciting a few facts, backed up by analyses and micrographs to show a few of the things that have been done with semi-steel. The concern just referred to has quit buying steel for making dies as semi-steel wears better, is easier to machine and is much cheaper. Fig. 4 is a micrograph of the die metal as it was originally cast in a bar or block 4 inches square by 20 inches long. The analysis is as follows: Combined carbon, 0.70 per cent; silicon, 1.45 per cent; sulphur, 0.092 per cent; phosphorus, 0.344 per cent; manganese, 0.81 per cent. The transverse strength is 3,800 pounds per square inch. This 4-inch bar was sawed in 1-inch square sections and turned down to ⅝-inch rounds for punches which have been working very satisfactory. Fig. 14 is an engraving made from an ordinary photograph of a punch that was soft and is remarkable in that it shows that semi-steel will stand quite a little bending without fracture. That is, of course, due to the smaller amount of graphitic carbon flakes. Figs. 27 and 28 are taken from a punch, Fig. 27 being the unetched specimen in which the dark colored flakes are graphitic carbon, the white ground being a mixture of iron and steel. The principal thing to note about this micrograph is the small size and small quantity of graphitic carbon flakes as compared with regular cast iron. Fig. 28 is taken from the same specimen but etched, so as to distinguish between the pearlite, which is steel, and the ferrite, which is iron. In this the white portions are ferrite, the rest steel. The black double lines are graphitic carbon particles. From this micrograph, the principal thing to be deduced is that the material is very nearly saturated with combined carbon, much more so than is usually found in regular gray iron. In other words, the material is practically a steel with small graphitic carbon flakes. Both of these micrographs are magnified 200 diameters.

Fig. 29 is taken from the edge of a semi-steel punch that has been carbonized and hardened. The white particles are known as cementite, which is an exceedingly hard, brittle substance composed of iron and carbon combined in the proportion of three parts of iron to one of carbon. At the edge, where the general color is considerably darker, there is not much of this cementite, in fact, the material has become lower in carbon and, therefore, while equally as hard,

(Concluded on page 82)

Safety in the Plating Room

By E P Later

THE LAST few years have witnessed a decided awakening on the part of both legislators and employers to the necessity of safeguarding workmen from all preventable dangers, shortening the hours of labor and making the surroundings as healthful and pleasant as reasonably can be expected. It needs no argument to show that these improvements have paid, that the workmen are more vigorous and contented, more efficient and more inclined to do a good day's work. Perhaps most manufacturers have made the necessary changes with good grace and those who were averse to doing so have been compelled to get in line with the spirit of the times and provide the proper kind of places for their employes.

Passing of the Old Plating Room

In consequence, the old-time factory, with its cheerful disregard of almost everything that comes under the head of modern sanitary ideas, is largely a thing of the past and with it has gone the ancient plating room, dirty, reeking with steam and acid vapors and altogether anything but a pleasant place in which to work. Some old relics still persist, however, and inasmuch as a finishing department presents certain unusual problems of its own and is not as easily kept in good order as some other work places, a few hints on the subject may not be out of place, especially as they embody the experience and practice of various foremen and factory managers.

Factory inspection and liability laws vary in different states and nothing would be gained by discussing them in detail, even if this were possible here, but in general, the intent and purpose of these is to protect workers, as far as possible, from accidents and conditions adverse to health and to insure compliance with them in a broad way by making the employer liable to an action for damages in the event of injury to the employed. Aside from the humanitarian aspect of the case, therefore, it behooves every factory owner to take all reasonable precautions to prevent such occurrences, even though some of the safeguards employed are not specifically called for in the laws of the state or city in which his plant is located.

For example, the installation of a ventilating system of sufficient size to keep the plating room fairly free from steam and fumes is well worth while, and efficient dust collectors for the buffing and grinding wheels are almost an absolute necessity. Putting the acid dipping jars under a hood with a good draught, or in a room by themselves, is highly desirable and even installing hoods over cyanide copper and other cyanide and hot water tanks is worthy of some consideration. Pure air always means increased efficiency.

Individual Lockers Recommended

In the matter of personal accommodations it is imperative, in many cases, and always desirable, that each man have a clean, individual locker of ample size, where the clothing which he wears to and from work may be kept safe and sanitary during the day, thus eliminating the necessity of wearing clothes which are full of metal dust or plating salts, along the street and in the home. This naturally brings up the question of bathing facilities and it goes without saying that these should be abundant. Plenty of hot and cold water, soap, towels and so on will make a world of difference in the appearance and feeling of a toil-begrimed workman and, incidentally, scrupulous cleanliness of face and hands at mealtimes is a highly important matter as it will go far toward lessening the chances of the various chemicals and other foreign substances finding their way into the system along with the food; therefore, it should be urged on the men and encouraged in every way.

Risky Performances

Of hardly less importance is the discouragement of the practice of eating between the regular mealtimes or taking a chew of tobacco without first washing the hands. The writer has seen workmen weighing-out or handling cyanide, and in the next breath taking a generous wad of the *weed* without even stopping to dust off their hands. Likewise, the practice of using a lump of this material, instead of soap, in cleaning the hands is hardly to be recommended. The mere fact that generally nothing seems to come from such performances does not prove that they are not risky and that serious results might easily follow a little extra carelessness. Familiarity may breed contempt, but it does not lessen the poisonous character of drugs and chemicals, and this should never be forgotten. Neat signs posted in conspicuous places and calling attention to some of these points will have a good effect in correcting them.

In a large establishment especially, there are almost certain to be found helpers who are of foreign extraction, ignorant, not accustomed to handling chemicals and unaware of the perils connected with their use. Such persons are generally a source of danger to themselves and others, so a little time and effort spent in educating them along these lines may prove very profitable. One of the first steps in a campaign of this kind is to put a sign on every tank and jar, stating the contents and further distinguishing those which are poisonous or dangerous. These labels need not be very elaborate; a piece of sheet iron painted black, with red or white letters will do all that is required. The actual wording, too, should be brief and to the point, thus: *Cyanide—DANGER; Nitric acid—DANGER; Nickel solution,* and so on. In the same way all containers of dry chemicals should be distinctly labeled so as to show what the contents is and its nature. If this is done there is much less excuse or liability of disastrous mistakes being made and there is the further element of safety for the factory owner, in that, in the event of any accident, it can be shown that the workmen have been warned of the dangerous solutions and chemicals, thereby making it encumbent on them to exercise the proper precautions. Much may often be accomplished also by judicious warnings given directly to the offenders, or by getting the confidence of the men and helping them to see that these measures are really designed for their protection and welfare.

Safety Cabinet

In spite of all the precautions which can be taken, however, mishaps are certain to occur once in a while and then the only thing to do is to give intelligent treatment, or at least first aid assistance, and thus help to repair the damage as soon as possible. The average small factory cannot afford to keep a physician on its staff, so it must depend on the foreman or others to take care of injured workmen until medical aid comes, if the case is serious enough to warrant the latter. Many times, however, a few minutes make a good deal of difference and a delay in stopping a heavy flow of blood or administering an emetic may be followed by very serious consequences. For this reason it is desirable to furnish each department, or group of departments, with a cabinet containing sterilized cotton, bandages, antiseptics, etc., with simple directions for using them. Such an outfit should prove very useful for the grinding and buffing rooms, but for the plating room proper other materials are needed as a different class of injuries and accidents are to be treated. Burns from acids or alkalis and poisoning by some of the various chemicals employed are met with here, so a cabinet of convenient size to contain the proper reagents should be put up in an easily accessible place. Needless to say, it should be well made, with a tight-fitting wooden or glass door, which should be kept closed by a spring catch, but not locked.

Cyanide Poisoning

Poisoning by cyanide is the most dangerous and most likely to occur and unless the proper treatment is very promptly given the patient may soon be beyond aid; therefore, it is the custom in some establishments to place the remedies for cyanide poisoning in a small, separate cabinet, where they can be found and used with the least possible delay, and this practice is to be recommended. This subject, therefore, will be considered by itself. However, a few facts about poisons and their effects, in general, may be of help in giving a clearer idea of the subject.

It must be borne in mind that the term *poisoning* is largely relative, since almost all of the substances we usually call poisons are useful medicinally in small amounts. Conversely, too much of anything is bad and substances which are beneficial in small amounts may be harmful if taken in excess. It is easily seen, therefore, that cases of poisoning may be of any degree of severity, from slight nausea to grave prostration.

Some poisons are absorbed and go into the blood without appreciably injuring the membranes. Alcohol and many drugs are an example of this.

Others act on the mucuous membranes with which they come in contact, destroying them to a greater or less extent and producing very serious results. Thus most acids, alkalis, arsenic, phosphorus and others belong to this class.

A physician should be called in all except slight cases, and even in these it is sometimes advisable. In the meantime, however, a good deal can be done to relieve the patient or even to save his life. The first thing to do is to neutralize or expel by vomiting, all unabsorbed poison in the stomach. The production of thorough vomiting, then, is resorted to in all cases with the possible exception of those in which strong acids or alkalis have been taken. It is generally better to neutralize these at once, without waiting for an emetic to act, as they work so quickly that grave damage may be done in a few moments and the straining produced by the emetic may cause perforation of the corroded walls of the stomach. Let the physician decide whether or not the stomach shall then be emptied by an emetic. When the poison has been expelled from the stomach we have to rely on the various excretory organs to rid the system of any noxious substances which have been absorbed by the blood. This process can be hastened, however, by giving a dose of some quick-acting purgative as magnesium sulphate (Epsom salts) or magnesium citrate. At this stage of the game it may be necessary to resort to stimulants, if the patient is very weak, or even artificial respiration may be needed. This is almost always required, of course, in asphyxiation, poisoning by gas. The details of this process may be had from most textbooks on physiology and need not be given here.

It may be noted, however, that the administration of emetics or antidotes is often rendered difficult by the patient becoming unconscious; the throat may be more or less completely paralyzed, or the jaws may be tightly locked. In the first event, the tongue should be prevented from falling back as suffocation may result. A lead pencil or spoon handle may be used to keep it down and forward. If the head is now tilted slightly backward and liquid poured in in a small stream it will readily slip down the throat. The same treatment will usually suffice when the throat muscles refuse to act. If the jaws are tightly shut they may be opened by running the thumbs or two fingers along between the teeth and cheeks and forcing them in at the back of the jaw where the teeth stop. The tongue then may be depressed and medicine poured in as before. Don't be afraid of drowning the patient; there is a delicate little valve in the throat which has been developing the last few millions of years for the express purpose of preventing that very thing.

Contents of Emergency Cabinet

An emergency cabinet should contain some of the more simple remedies, tightly corked, plainly labeled and ready for instant use. The following will be found useful:

Ammonia, aromatic spirits.—An excellent stimulant; dose, one-half to one teaspoonful in one-half glass water. Repeat as often as necessary.

Boric acid.—A mild antiseptic; use a 5 per cent solution, about one ounce of the acid to one pint of water.

Calcium hydroxide, lime water.—Used in poisoning by acids. Place a lump of slaked lime as large as a walnut in a quart bottle. When using, do not disturb the sediment at the bottom.

Magnesium sulphate, Epsom salts.—An efficient purgative. Dose, two to four teaspoonfuls in a glass of water. Sodium sulphate may be used in place of this.

Mustard.—A good emetic, also acting as stimulant; dose, one tablespoonful in one glass of water, stirred thoroughly. Give one-fourth of this at once, followed by one glassful of luke warm water. Repeat at intervals of one minute until vomiting occurs.

Sodium bicarbonate, baking soda.—A good ant-acid; used for acid burns and poisoning by certain metallic salts; dose, one or two teaspoonfuls in a glass of water.

Sodium chloride, common salt. — Emetic; dose, one teacupful of a saturated solution in warm water.

Zinc sulphate.—An excellent emetic, especially in poison cases; dose, 20 grains, as much as can be heaped on a silver quarter, in water followed by a cup of lukewarm water; repeat in three minutes, if necessary.

Among the cases most likely to be encountered, the following may be mentioned:

Acids, hydrochloric (muriatic) nitric and sulphuric; these act very rapidly. Symptoms: Intense burning pains, thirst, exhaustion, collapse. Treatment: Neutralize by lime water, magnesia or soap suds, giving frequent and liberal doses. It is often best not to give carbonates, as baking soda, for the gas generated may strain the stomach. Let a physician decide about an emetic. When the acid is neutralized give milk, olive oil or barley water freely.

Inhalation of the fumes of these acids causes difficulty in respiration, suffocation. Treatment: Fresh air, artificial respiration, if necessary, and inhalation of dilute ammonia.

All of these acids cause serious burns when in contact with the skin. Treatment: Wash-off in running water and bandage with cloth soaked in saturated solution of sodium bicarbonate.

In the event of acid being splashed into the eyes, wash well with water, then with a dilute solution of sodium bicarbonate, one teaspoonful to a glass of water; follow by clean water again or boric acid solution. Consult a physician.

Alcohol, grain, denatured or wood, shellac solutions, all of these are somewhat poisonous, wood alcohol especially so. Symptoms: Confusion, giddiness, stupor. Treatment: Give mustard, zinc sulphate or salt as emetic. Stimulants, aromatic spirits of ammonia or strong coffee, or artificial respiration if there is much prostration. Do not use cold douches, keep body warm by flannels or artificial heat.

Alkalis, caustic soda, potash or ammonia and cleaning solutions also act very rapidly, producing about the same symptoms as the acids. Treatment: Neutralize by an acid, vinegar or lemon juice diluted with their own volume of water, or one or two teaspoonfuls of sulphuric or hydrochloric acid in one pint of water. Repeat the dose two or three times, then give an emetic, mustard, zinc sulphate or salt in water; follow by copious draughts of milk, olive oil or barley water.

Copper, sulphate, carbonate and other salts, (for cyanide baths see under treatment for cyanide poisoning) the symptoms are pains, cramps, sometimes metallic taste in the mouth. Treatment: Give milk or white of egg in water or both very freely. Or the copper may be rendered insoluble by giving a half teaspoonful of sodium bicarbonate in water every few minutes until two or three doses have been taken. An emetic, mustard, zinc sulphate or salt then may be administered, if necessary.

Gold, from plating baths. See under treatment of cyanide poisoning.

Lead Poisoning

Lead, from acetate (sugar of lead) or other lead salts, the symptoms are pains and sweat, metallic taste, colic relieved by pressure. Treatment: Render metal insoluble by giving sulphates, as Epsom salts or sodium sulphate, a heaping tablespoonful in a glass of water. Afterward empty stomach by mustard or other emetic. Follow by plenty of milk, barley water, or white of egg in water.

Mercury, from the bichloride (corrosive sublimate) or other salts, is a very dangerous poison; it rapidly destroys the stomach and affects the internal organs, especially the kidneys. If taken in any quantity it is generally fatal, unless very promptly treated. Symptoms: Colicky pains, coppery taste in mouth. Treatment: Give white of egg in water very freely, together with milk. Follow by emetic of mustard. A physician should be summoned at once.

Nickel, from plating solutions or any of its salts. Symptoms: Same as for other metallic poisons. Treatment: Give an emetic, mustard, zinc sulphate or salt.

Silver, see under treatment for cyanide poisoning.

Tin, from the chloride or any of its salts. Symptoms: Same as for other metallic poisons. Treatment: Give an emetic, mustard, zinc sulphate, or salt in water. Follow by one tablespoonful of sodium bicarbonate in a glass of water, or one-half glass of milk every 15 minutes for two or three doses.

Zinc, from the chloride, sulphate and other salts. These are poisonous when taken internally, but exert such a marked emetic effect that they are soon ejected and are not liable to cause as serious results as some of the other metallic salts. Symptoms: About the same as for other metallic poisons; pains, sickness, vomiting. Treatment: Give teaspoonful bicarbonate of soda in one-half glass of water, followed by copious draughts of milk.

The cabinet should contain a large tin cup, spoon, a bottle containing 30 cubic centimeters of a 5 per cent solution of potassium hydroxide, another one with an equal amount of a 23 per cent solution of ferrous sulphate and a third bottle or package containing about 2 grams of powdered magnesia. The bottles should be tightly corked and plainly labeled.

Cyanide, from the potassium or sodium salts and all solutions containing cyanide; gold, silver, copper and brass plating baths, cyanide dips and so on, constitute the most violent and fatal poisons known and only very small amounts are required to produce severe disturbances or death. One characteristic is the extreme rapidity of the action, in fact a case is practically hopeless if any quantity of the poison has permeated the system, although every effort should be made to combat it. For obvious reasons, therefore, strict precautions should be exercised in handling this material; the dust from it should be avoided and the hands and arms kept out of such solutions as much as possible. When it is necessary to dip them in they should be washed in water at once. Cyanogen gas, which is given off when a cyanide and an acid come in contact, is also extremely poisonous and great care should be taken to prevent accident from this source.

The fumes given off from cyanide plating baths do not, as a rule, prove dangerous, but should not be inhaled more than necessary.

Symptoms: These may vary from dizziness and lack of control of the muscles to terrible convulsions and almost instant death, depending on the amount of the poison which has found its way into the system. Treatment: As quickly as possible mix in the tin cup the solutions of potassium hydroxide and ferrous sulphate and the magnesia, then administer this to the patient. If he is not conscious it will be necessary to pour it down his throat a little at a time. It may be followed by a mustard emetic, then stimulants, strong coffee, aromatic spirits of ammonia, may be given. Cold douches to the spine also are helpful. A physician should be summoned at once.

In continued contact with the skin, cyanide solutions are absorbed in sufficient amounts to cause a slow form of poisoning which may become serious if neglected. Sores break out on the arms and body, the skin of the hands and arms becomes brownish and the nails turn dark. A patient in this condition may need careful medical attention and should be taken away from cyanide work.

Casting Steel Wheels for Motor Trucks

THE modern motor truck, weighing tons and carrying a burden equal to its own weight as it jogs over the poorest of pavements or plods steadily through mud and sand, is a masterpiece of engineering accomplishment. The rubber tires, the electrical equipment, the aluminum parts, the heat-treated springs and the many intricate castings are the products of advanced technical knowledge and efficient, skilled workmanship. The success of the motor truck has been particularly contingent upon improved methods of foundry practice which are accomplishing results today that 10 years ago were considered impracticable, if not impossible. One of the interesting problems of foundry practice which was introduced by the development of the complete motor truck is that of making cast steel wheels.

Adherence to Precedent Retarded Progress

The motor truck was not universally successful until the engineers took up separately each one of the many different parts that are included in the assembly of the truck, designing each of these parts to withstand the particular stresses to which it is subjected. It is interesting to note that the same tendency to follow precedent that led the first builders of pleasure cars to put a whip socket on the dashboard, influenced the earlier truck builders to fit a truck body on the chassis of a pleasure car. This simple expedient proved satisfactory for light work on good roads, but as the demands for better service increased and the fields opened to the motor truck were broadened, the fallacy of this makeshift became evident and makers then began to develop the parts of the truck from the standpoint of the service for which this vehicle is intended. Similarly, it was not until the universal utility of the motor truck was foreseen that builders realized that they must disregard old established theories and precedents and strike out in new channels. When this point was reached, the time honored wooden wheel was abolished

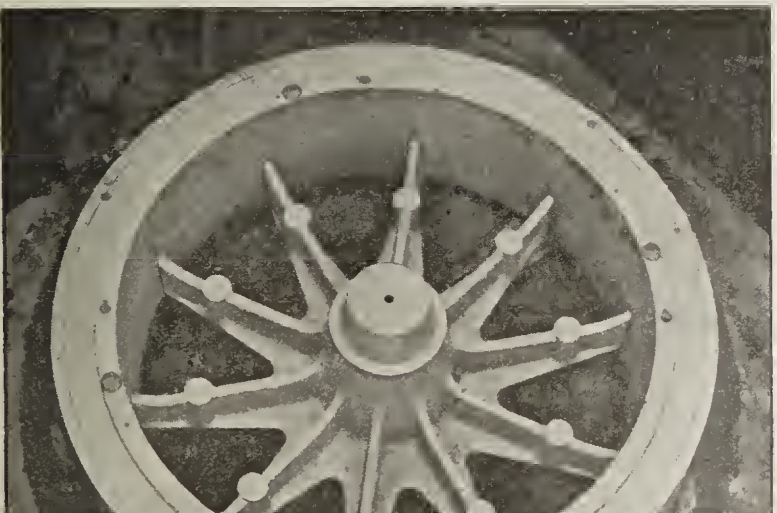


FIG. 1—ALUMINUM PATTERN, DRAG HALF, USED FOR MOLDING STEEL TRUCK WHEEL.

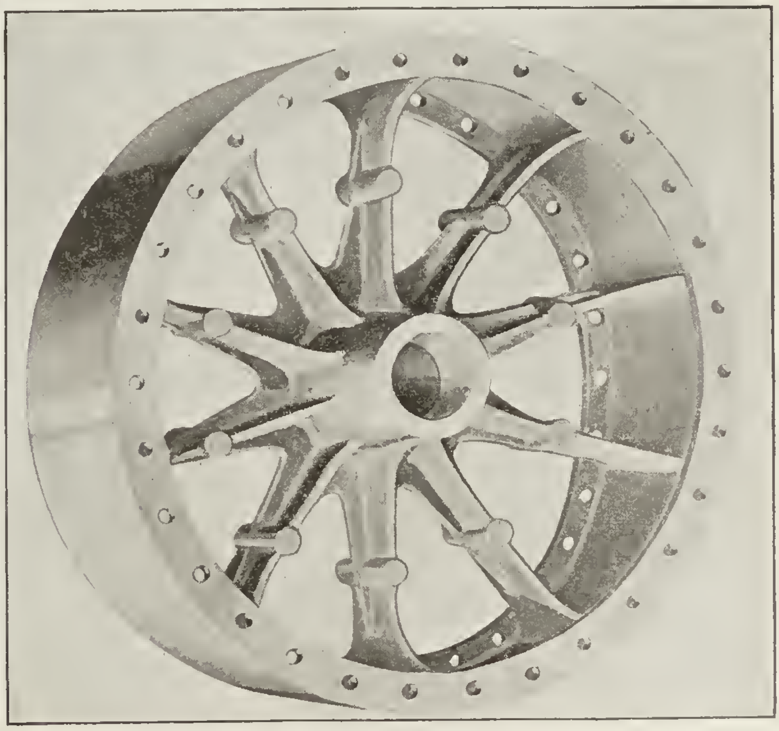
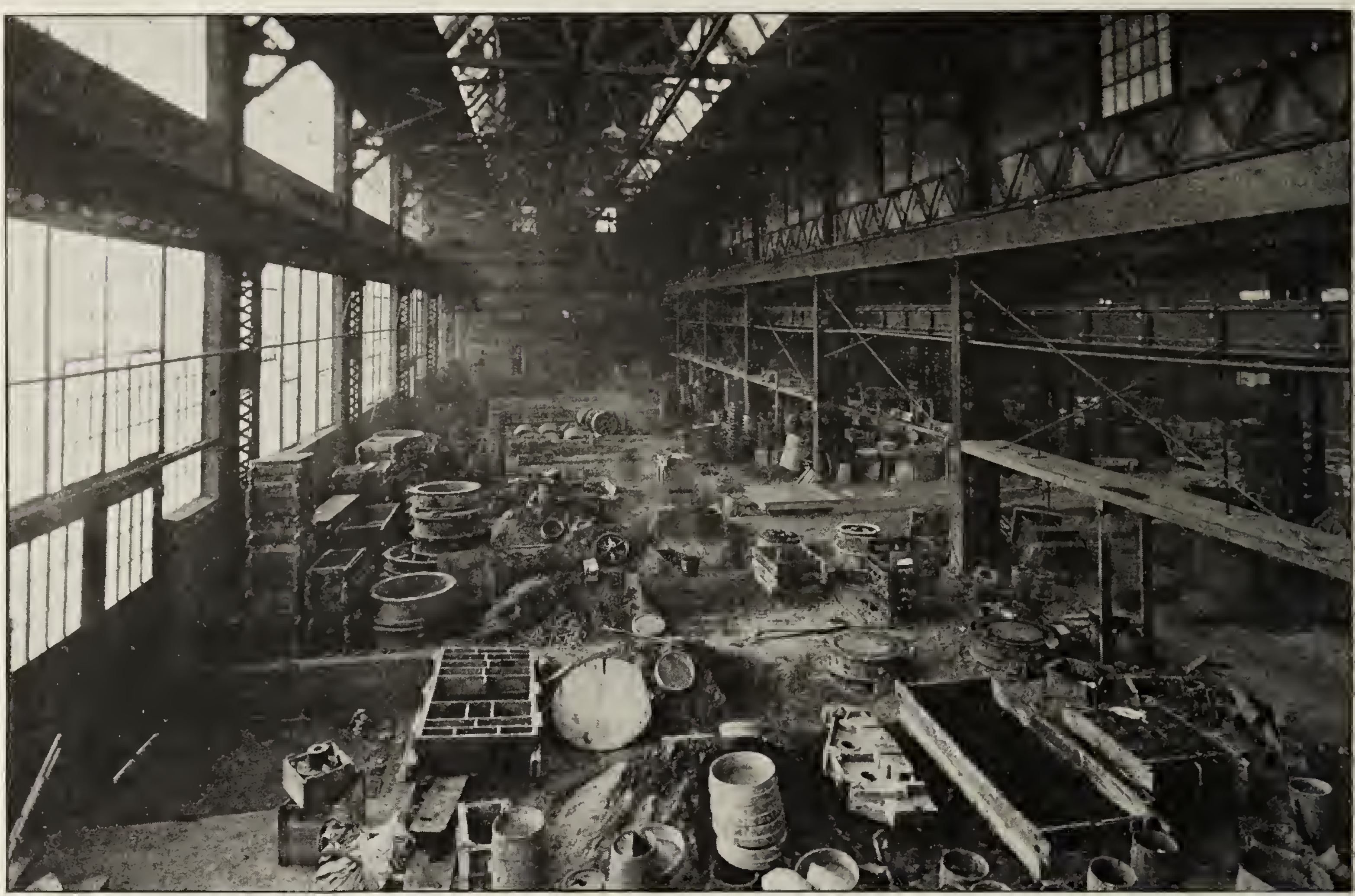


FIG. 2—FINISHED STEEL WHEEL



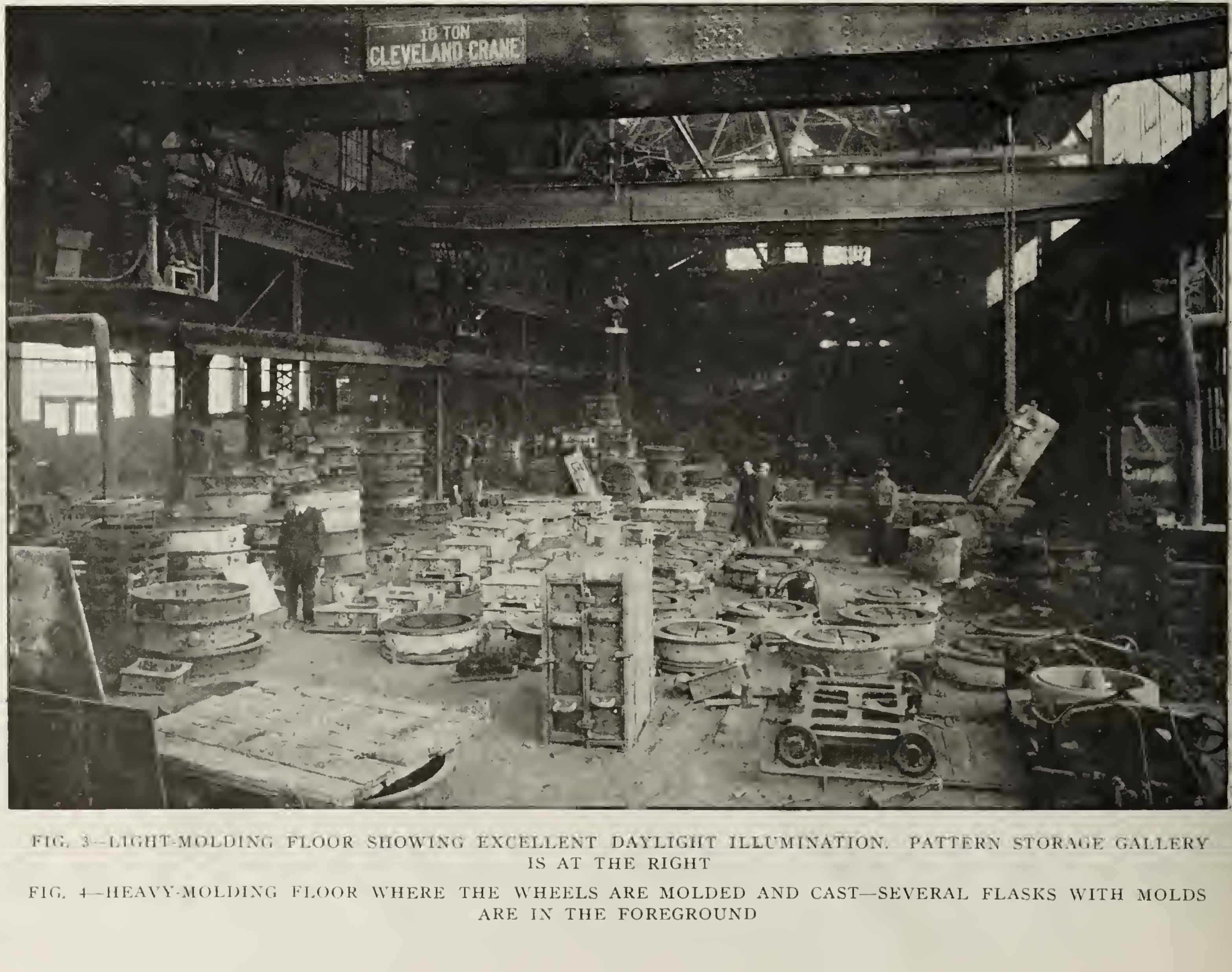


FIG. 3—LIGHT-MOLDING FLOOR SHOWING EXCELLENT DAYLIGHT ILLUMINATION. PATTERN STORAGE GALLERY IS AT THE RIGHT

FIG. 4—HEAVY-MOLDING FLOOR WHERE THE WHEELS ARE MOLDED AND CAST—SEVERAL FLASKS WITH MOLDS ARE IN THE FOREGROUND

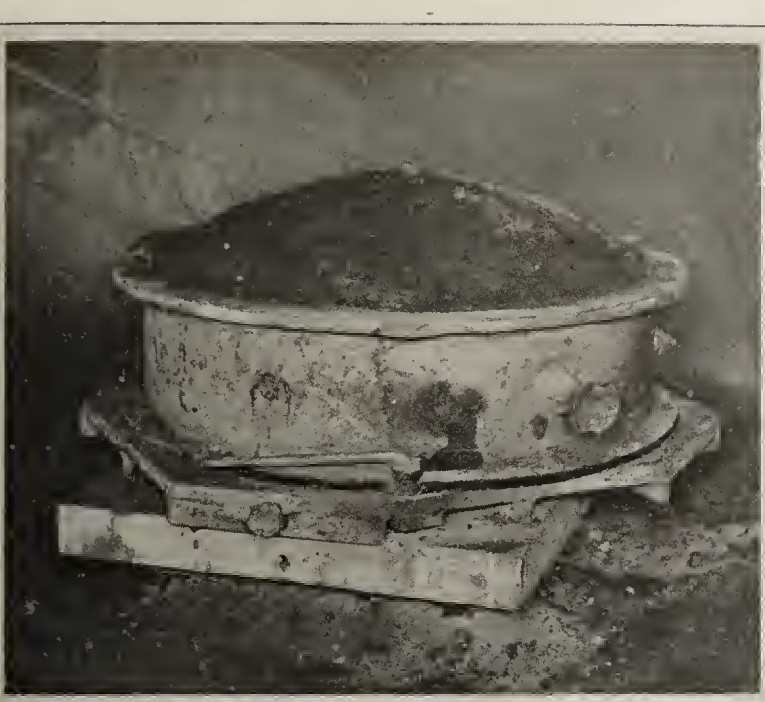


FIG. 5—FLASK ON JAR-RAMMING MACHINE. ABOUT 40 BUMPS RAM THE MOLD.

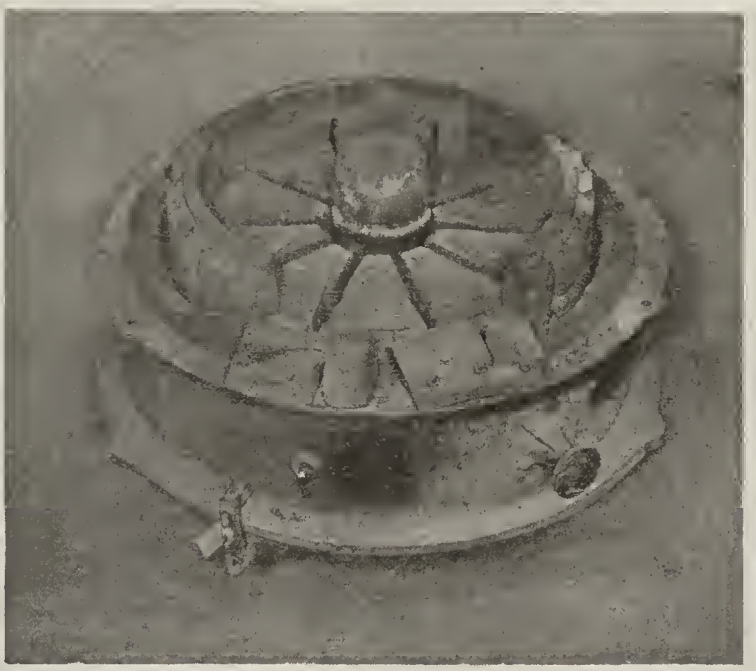


FIG. 6—MOLD WITH PATTERN REMOVED SHOWING CORES PARTIALLY IN PLACE

and the strong, reliable steel wheel took its place on the modern motor truck. The making of steel wheels involves a number of interesting foundry problems and their production at the plant of The West Steel Casting Co., Cleveland, is unusually interesting because extreme care and skillful workmanship are producing extraordinary castings by applications of ordinary foundry principles.

Steel motor truck wheels must be designed to carry not only the safe estimated load for which the truck is built, but also must provide a large factor of safety, due to the fact that because the wheel is steel, it is subjected to excessive abuse by the truck driver, the garage men and the tire repair men. Because a wheel is steel, it is often expected to withstand the blows of the largest sledge-hammer a mechanician can lift or the roughest roads a truck-driver can find. If wooden wheels were submitted to this abuse, they would last only a short time. A man with steel wheels on his truck seems to forget that curbs line roadways and that crossings are raised above the street level. The truck wheel must be in proper condition if satisfactory tire service is to be maintained. The man driving a truck with wooden wheels takes no chances, as a rule, and is ever mindful that a side thrust or sudden jolt may loosen the wheels and cause tire trouble. The ability of steel wheels to retain their shape permanently simplifies the procedure in changing tires, even after the truck has been in service for years.

A split pattern, the drag half of which is shown in Fig. 1, is used in making the mold for the steel, auto-truck wheel. The pattern is made of aluminum to avoid the liability of errors due to the warping of wooden patterns and to insure satisfactory wearing qualities. The illustration shows the drag half of the pattern mounted in the combined follow-board and pattern plate. The follow-board is a finished steel casting and is drilled to a standard jig so that the wheel patterns may be mounted interchangeably. The pattern is held in position with dowels and small lugs and is bolted to the plate with three or four small round-headed bolts in such a manner that it is impossible for it to jar loose.

The cope half of the pattern is practically the same as the drag half. The shape of the rims of the two halves is identical, the only difference between the two halves being that the core is made larger than the drag to provide additional axial bearing for the cope side

FIG. 7—THE CORES ARE ALL MOLDED BY HAND.

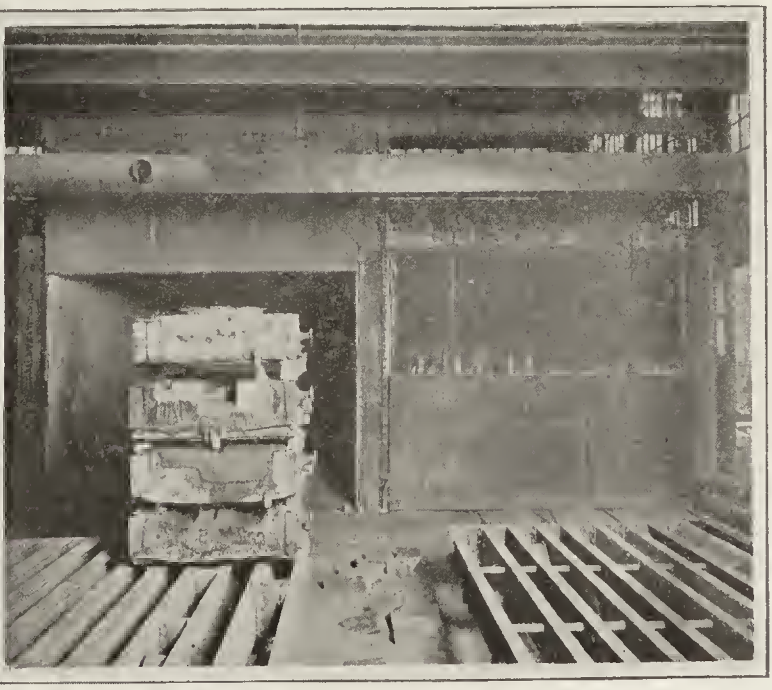


FIG. 8—THE CORES ARE BAKED AND DRIED IN A GAS-FIRED OVEN

of the wheel which carries the heavier loads and is subjected to greater stresses than the other side. All the fillets on the pattern are carefully rounded, thus eliminating sharp corners and precluding the occurrence of checking or invisible defects which might later be the cause of the failure of the wheel.

Fig. 5 shows the pattern with the flask in place on an Osborn plain jar-ramming machine ready for the ramming. Five machines of this type are used in this plant. A smooth surface is given to the casting by using a fine grade of silica sand facing. Portage and Ottawa sands have found preference in this foundry. The green sand used in making the molds is mixed with a binder of clay and molasses water. The sand used is mixed in a 6-foot sand-grinding machine built by the Thomas Carlin Sons Co., Pittsburgh. After the flask has been filled with sand and the gaggers and bars have been placed in position, the mold is ready for ramming. This is accomplished with from 40 to 50 bumps, using air at about 80 pounds pressure. The jar-ramming machines are mounted on solid concrete bases about 15 inches thick, so arranged that the flask, when resting on the machine is at a convenient height for the molder and his helpers.

From the time each mold is started until it is finally closed, ready for pouring, the work is handled by a molder and two helpers. A single molding crew is able to turn out 10 complete molds per day. The daily production of the wheel department varies from 50 to 100 wheels.

The wheels are molded at the lower end of the heavy molding floor near the sand department and are carried by cranes to the part of the bay shown in the foreground of Fig. 4, where the pattern is withdrawn and the chills, heads and gates are placed preparatory to pouring.

Placing the Chill Plates

After the pattern is withdrawn, the mold is finished by slicking and retouching by the molder if necessary, after which nails and chills are placed at all intersecting points where the metal of the wheel is of uneven thickness. The extreme variation of metal thickness occurs at the intersection of the arms with the tire flange and particular care is taken, therefore, to secure rapid cooling at these points to avoid changes of porosity or sponginess. The impressions of the chill plates on the rim of the wheel are shown clearly in Figs. 12 and 13, which illustrate the rough casting ready for the cleaning and chipping department, after the sand has been removed. The drag half of the flask, setting on the floor with a rim cores partially placed, is shown in Fig. 6. This illustration shows the simplicity of the mold after the pattern has been removed. The large hub core, with the core print which provides for the additional axial bearing of the cope side of the wheel may clearly be seen in this view.

As these particular molds are made in green sand, it becomes necessary to skin-dry them to reduce the erosive action of the molten metal and to climinate as completely as possible the formation of gases. The general result obtained from this drying operation is a casting, fairly smooth of surface and free from gas pockets. The drying is accomplished with portable, gas-fired burners. Each part of the mold is dried independently before the cores are placed and the entire mold is assembled.

The rim cores are made in uniform sections, one-half of a complete core to each spoke section. One-half of the core is placed in the drag and the other half in the cope. When center line of the rim is in line with the center of the hub, the two halves of the rim core are exactly alike, but when the rim is offset, as is often the case, there is a variation in the width of the cores. The cores are all hand-molded with a rosin and molasses binder and are baked in rolling-drawer, gas-fired core ovens, shown in Fig. 8. The core department, with some of the finished cores in the foreground, is illustrated in Fig. 9. After all the cores have been assembled in the mold, the cope is placed on the drag and the mold is headed and gated preparatory to pouring. The cope as it appears when finished, may be seen in Fig. 9, suspended by one of the 10-ton traveling cranes. The flask was slightly tilted to provide a better view of the cope and to illustrate the similarity of the two parts of the mold. One important condition in making such a mold is that the body of the sand be soft enough to allow the casting to shrink as the metal sets. Such a casting, in this case, a wheel approximately 36 inches in diameter with a 12-inch face, will shrink nearly ¾-inch in cooling. This shrinkage imposes a condition which makes it necessary for the sand to allow ¾-inch compression without offering too much resistance to the cooling metal. If the sand did not yield as the metal cooled, internal strains would result which would be of serious consequence when the wheel is subjected to shock in actual service.

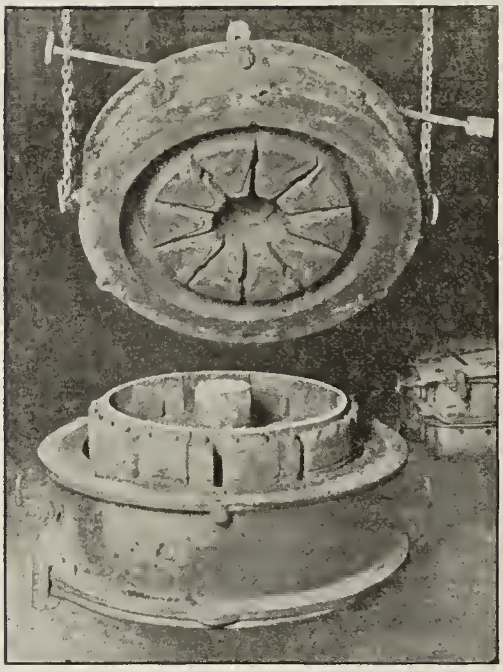


FIG. 9—PLACING THE COPE ON THE DRAG

Gating and Heading Important

Successful castings are contingent upon proper gating and heading. In the process of making steel wheels, the selection of the best gate position is of the utmost importance. In addition to this requirement, the head provided must be such that it will feed-up the shrinkage which takes place when molten steel passes into the solid state. The gate must provide an opening to the mold for the molten steel, allowing the metal to flow as rapidly as is necessary for the condition at hand. Some wheels having light rims may be gated from the outside and others having light hubs and heavy rims are best gated at the center. If the wheel is designed with fairly substantial arms or spokes, the mold may be gated on one of these.

The wheel described in this article is prepared for pouring with a gate located at the hub, the spokes being of such cross-section that the molten metal flows easily to all parts of the rim. The gate is approximately 1½ inches in diameter. The two heads are oblong in section, about 3 x 6 inches, and 6 inches high and are located at the center of the hub. This column of metal, which weighs close to 40 pounds per head, is sufficient to compensate for the shrinkage. In the views of the rough casting shown in Figs. 12 and 13, the point of gating is shown at *G* and the points at which the heads were taken off at *H H*. The mold, in position, ready for pouring is clearly shown in Fig. 10.

To secure uniformity of product, it is necessary to pour all the wheels at a uniform temperature. This temperature of metal is best determined by experience. The gate should be designed, however, so that it will allow the ladleman an opportunity to pour the metal into the mold rapidly. The best results are obtained by keeping the temperature of the metal at such a point that it will pass into the mold and fill all parts of the rim and spokes quickly and evenly without causing any cold-shuts at points where the streams of metal converge. The castings are allowed to cool in the mold, care being taken to avoid cold drafts of air, thus preventing cooling strains.

The steel which is used for motor-truck wheels is produced in side-blow converters. Inasmuch as the steel is produced by the acid process, only bessemer grade of raw materials is acceptable. The pig iron used by the West Steel Casting Co. is of the following average analysis: Phosphorus, 0.025 per cent; sulphur, 0.03 per cent; silicon, 2.50 per cent; manganese, 0.50 per cent, and total carbon 4.00 per cent. In purchasing such steel scrap as is required, rigid specifications proved by metallurgists' examinations assure the company that the material is unusually low in phosphorus and sulphur and is free from traces of copper. The maximum of phosphorus and sulphur accepted in steel scrap is 0.04 per cent. The pig iron and the steel scrap are first melted in a standard 48-inch cupola which has a capacity of about four tons an hour. The hot metal from the cupola is conveyed to one of the conveyors by a 10-ton- overhead traveling crane. When the refining process is completed, the metal is transferred to a bottom-pour ladle and is carried to the place of pouring by overhead cranes. The cupola and converters are located in the section of the plant back of the heavy molding floor. Analyses of the metal contained in the wheels show the following average percentages of the different elements: Carbon (combustion), 0.208 per cent; manganese, 0.760 per cent; phosphorus, 0.011 per cent; sulphur, 0.045 per cent, and silicon, 0.325 per cent.

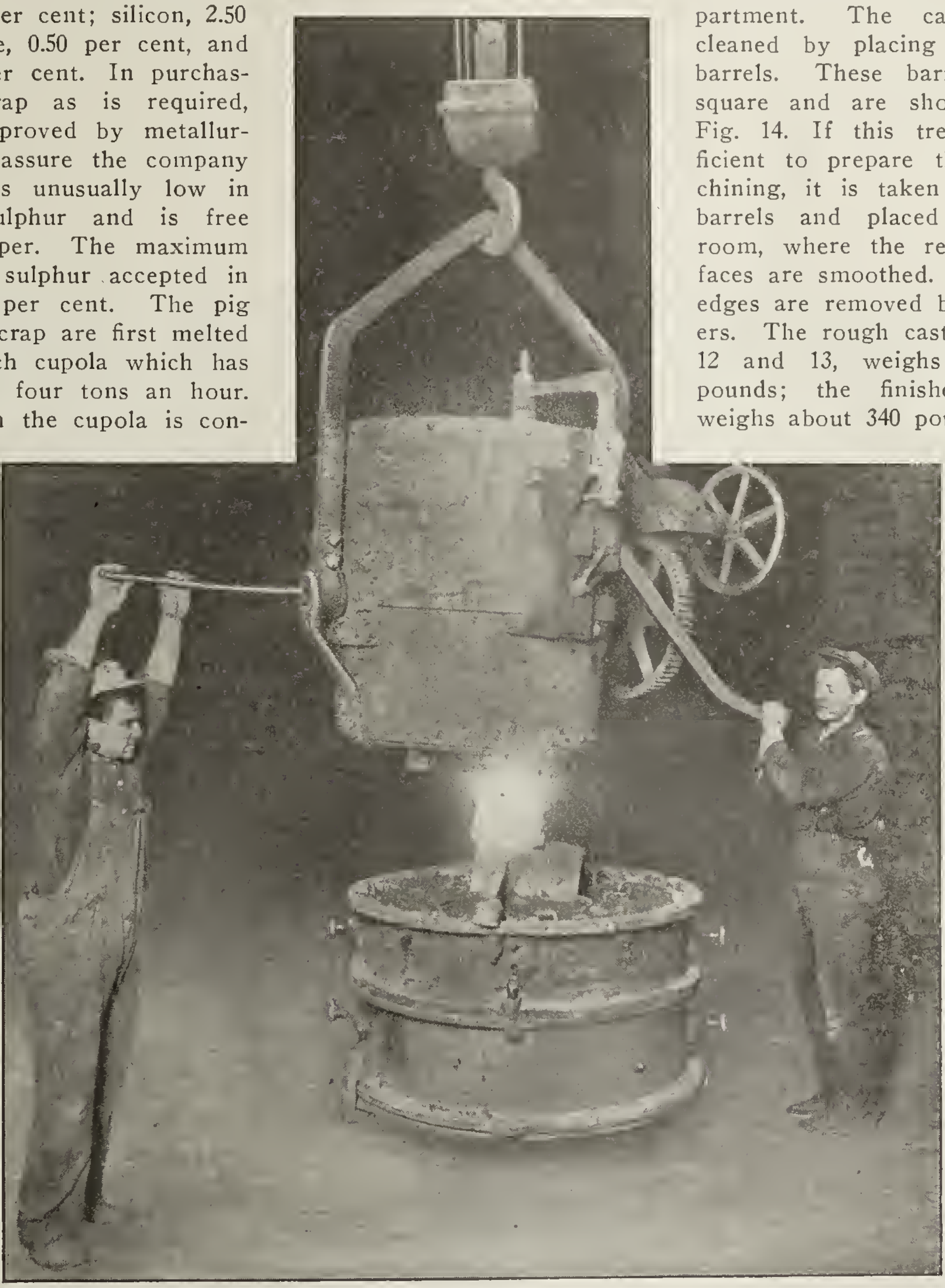


FIG. 10—THE STEEL IS POURED INTO ONE LARGE GATE ON THE HUB OF THE WHEEL. TWO HEADS, ALSO ON THE HUB, MAINTAIN THE PRESSURE ON THE MOLTEN METAL

Steel wheels for special motor-truck service appear to be a simple problem in foundry practice upon superficial consideration of the question, but only those who have had actual experience in their production understand the troubles and difficulties encountered in turning out a product that is free from all internal strains and weaknesses which are liable to give road trouble. As an example, two wheels may be cast from the same ladle of metal, one mold receiving proper care and attention from the setting-up of the pattern to the finishing or shipping of the rough casting, and the other being run through the various stages of production under ordinary conditions; if these two wheels are subjected to similar tests, the faults incident to the lack of care in the foundry soon will be evident. A practical test would be to drop the two wheels separately from the same height, say 10 feet, to a block below. The wheel that was given every care and consideration during its course through the foundry will show no defect or injury as a result of this test, while the other wheel, which was not properly handled by experienced workmen, would be almost sure to break or crack. The fracture of these wheels is most likely to occur where the spokes join the flange. A rupture at such a point is usually caused by cooling strains.

After the sand has been removed from the casting and the cores knocked out, the heads and gates are removed with chipping hammers. At this stage, the casting is sent to the cleaning department. The castings are rough-cleaned by placing them in tumbling barrels. These barrels are 36 inches square and are shown at the left in Fig. 14. If this treatment is not sufficient to prepare the casting for machining, it is taken from the tumbling barrels and placed in the sand-blast room, where the remaining rough surfaces are smoothed. The large fins and edges are removed by swing arm grinders. The rough casting, shown in Figs. 12 and 13, weighs approximately 500 pounds; the finished wheel, Fig. 2, weighs about 340 pounds. It is interesting to note, while considering various weights, that the steel wheels for light trucks actually weigh less than wooden wheels and that steel wheels for larger trucks weigh but slightly more than wooden wheels. The main feature, which is giving the steel wheel so much popularity — as was mentioned previously, is its great strength and reliability. After each casting has been rough - cleaned, it is annealed for about eight hours in an oil-fired furnace at a temperature of 1,650 degrees Fahr. Several of these furnaces, which are of the car type, have a capacity of nine large or 15 small wheels. They were furnished by the Strong, Carlisle & Hammond Co., Cleveland.

The wheels are machined under rigid specifications in an outside plant. Large heavy-duty boring mills are used for this purpose and since rapidity in production is greatly desired, the cutting tools are designed to take heavy cuts.

The foundry buildings of The West

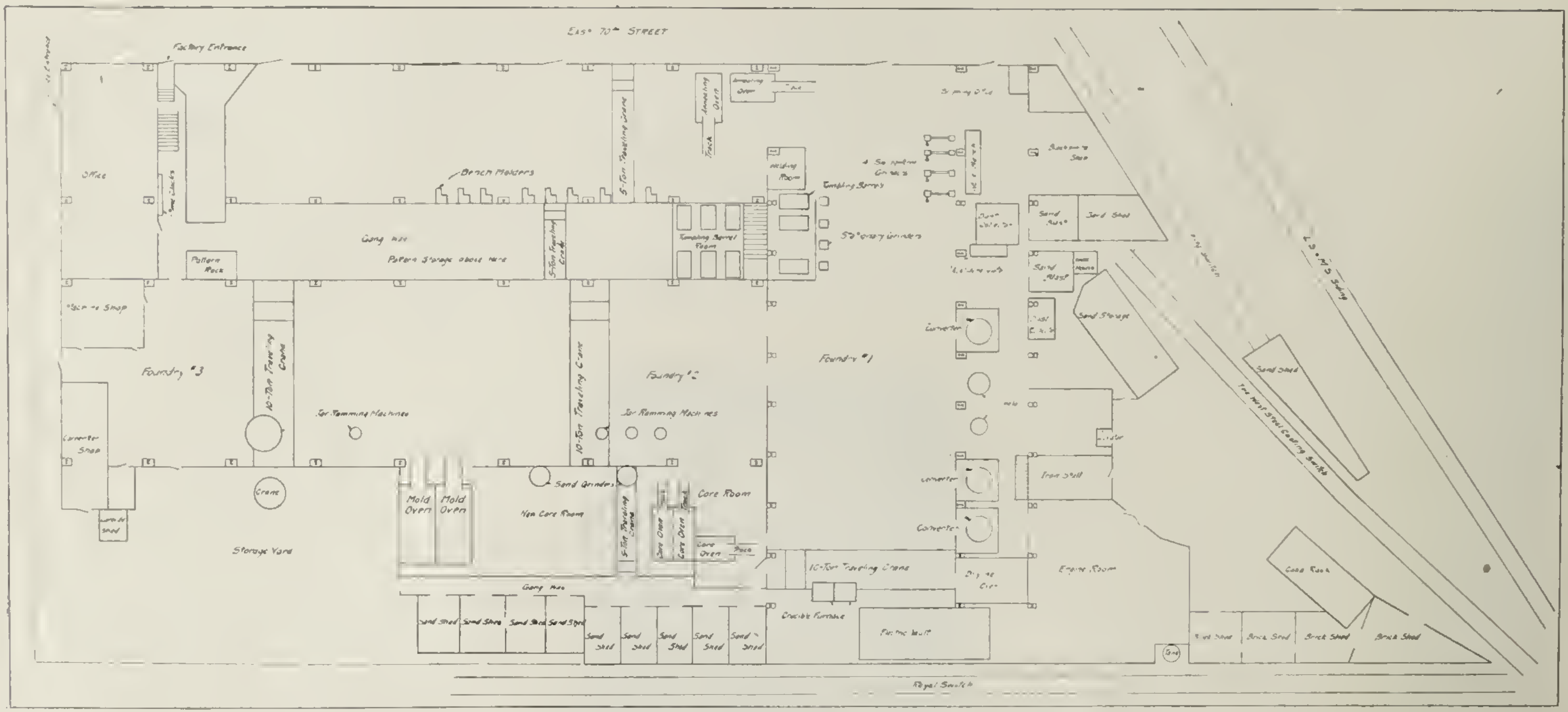
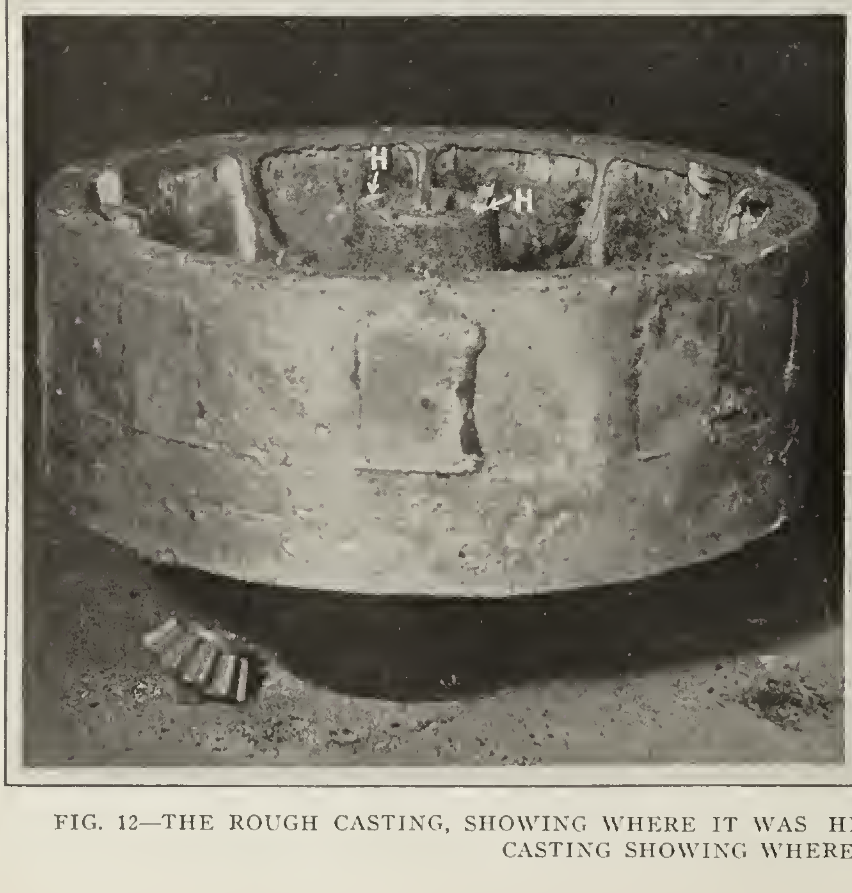


FIG. 11—PLAN OF THE WEST STEEL CASTING CO.'S FOUNDRY

Steel Casting Co. have some noteworthy features of construction and arrangement. The floor plan is shown in Fig. 11. The old portion of the plant, now houses the cleaning and roughing department, the sand-blast room, the convertor and cupolas. A 10-ton Cleveland crane handles the stock in this part of the plant. At the rear of this building is the powerhouse, where the energy that is purchased from the local power company is received and distributed through a switchboard to the various parts of the foundry. Accidental contact with any of the live parts of this board is prevented by ingenious protective covers of asbestos board. In this house, are also located the air compressors which serve the air tools on the foundry floor and also furnish the blast for the cupola and converters. All of the stationary motors used in various parts of the plant were furnished by the Reliance Electric & Engineering Co., Cleveland. General Electric equipment is used on the cranes and in the powerhouse where a rotary converter provides direct current for the crane motors. All other electrical apparatus is actuated by alternating current. Large gas-filled lamps, with special distributing reflectors mounted near the roof, provide artificial illumination.

A new section of the foundry was completed recently. It embodies features of construction which serve to make this part of the plant ideal for casting purposes. The two side walls, running the length of the building, are provided with exceptionally large windows, which being of special glazed glass, transmit an ample supply of daylight without irritating glare. Additional light is supplied to the molding floors from the skylights in the roof. The evenly distributed illumination of the molding floor is illustrated in Fig. 3 which shows the windows at the side and the skylights above. The modified saw-tooth construction of the roof was designed to provide an effective means of expelling the gases and admitting fresh air. The openings are at the highest point in the roof, so that the



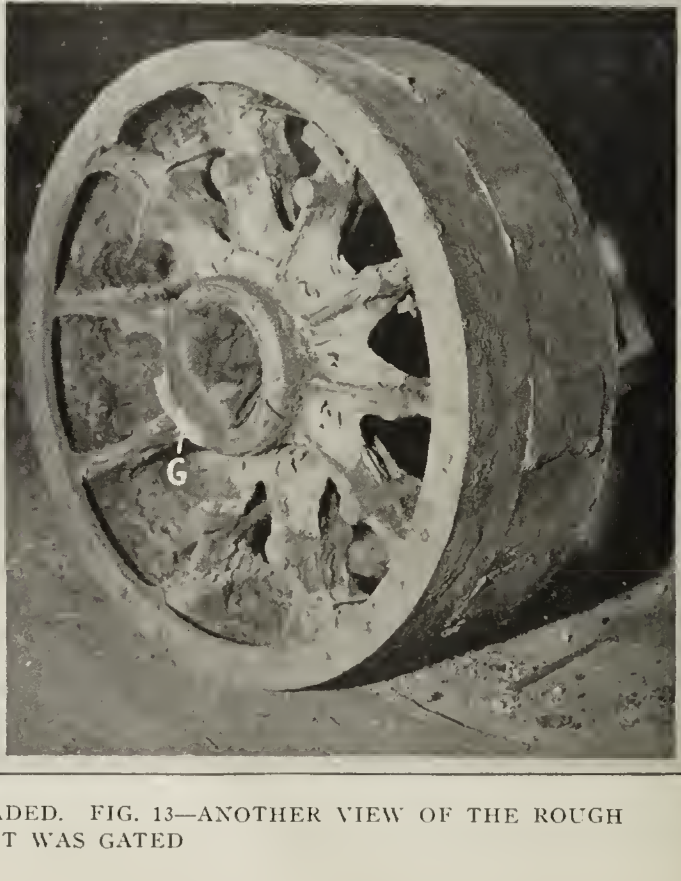


FIG. 12—THE ROUGH CASTING, SHOWING WHERE IT WAS HEADED. FIG. 13—ANOTHER VIEW OF THE ROUGH CASTING SHOWING WHERE IT WAS GATED

hot gases upon rising are immediately expelled. This feature is particularly valuable in hot weather when it is desirable to eliminate hot gases quickly. This section of the new building is served by a 5-ton Cleveland crane; the heavy-molding floor requires the combined facilities of two 10-ton cranes made by the same company.

A fire-proof pattern storage vault is located under the roof in the section of the new building between the light and the heavy-molding floors. This vault was added to afford protection against loss by fire of the many valuable patterns belonging to the company's customers. Steel racks provide simple and convenient means of storing the patterns. Fig. 3 shows the gallery containing the pattern-storage rooms. The bench molding department is located directly beneath this gallery. The section of the foundry devoted to heavy molding is shown in Fig. 4. This portion of the plant is of the same construction as the part containing the light molding department. The offices of the company are located at the extreme end of the new building. The new addition is arranged so that it may be extended easily when it becomes necessary to enlarge. The castings are shipped from the building which houses the cleaning and roughing departments. This structure is conveniently located on the main line of the New York Central railroad.

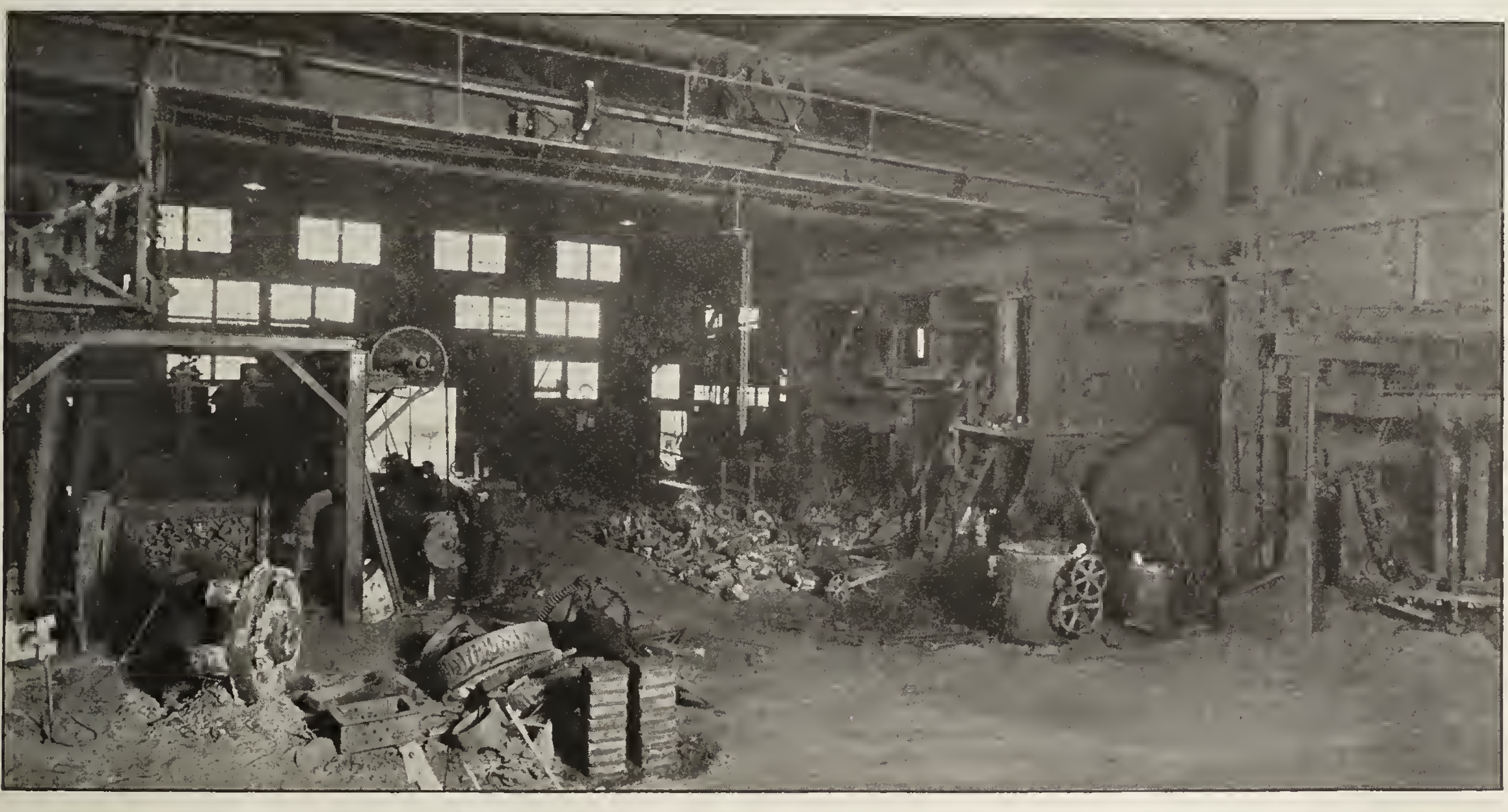


FIG. 14—CLEANING AND CHIPPING DEPARTMENT. THE CUPOLA IS AT THE RIGHT

The production of refined lead from domestic and foreign ores in 1916 was 579,600 tons, valued at $78,826,000, compared with 550,055 tons, worth $51,705,000 in 1915. The figures for last year do not include an estimated output of 21,800 tons of antimonial lead worth approximately $4,283,000.

Melting in a Cupola With Bituminous Coal

By John M. Dietz

The operation of a foundry out here in Nevada, thousands of miles from the base of raw material supply, is beset with many difficulties and recently when the coke shortage became acute, our bins were cleaned out and we were confronted with the problem of either shutting down our shop in spite of the heavy demand for castings, or to resort to some fuel other than coke to melt the iron. For the purpose of making a trial heat, we had several tons of bituminous coal shipped to the foundry from our smelter and the first heat, which was small, was cast into hard liners, since it was known that the coal was exceedingly high in sulphur.

Method of Charging First Heat

The first trial proved so successful that we determined to make regular heats and to pour our general run of castings from metal melted this way, notwithstanding the fact that no coke was available for this purpose. Our cupola is lined to 34 inches and the blast pressure practically throughout these heats was 12 ounces. The method of charging the first heat follows: The bed consisted of gas house coke, 250 pounds; bituminous coal, 400 pounds, on which 800 pounds of scrap iron was charged. The succeeding four charges of bituminous coal were 300 pounds each, with 600 pounds of scrap iron for each charge. This made a total charge of bituminous coal and gas house coke of 1,850 pounds and 3,200 pounds of iron. It is true that our melting ratio was unusually high, nevertheless the results were satisfactory. The fire was lighted at 11 a. m., the iron was charged at noon and the blast was put on at 12:30. Bottom was dropped at 3 p. m., and the drop was clean with practically no slag.

On the succeeding day we made another heat, the bed charge of which consisted of 250 pounds of gas coke and 400 pounds of bituminous coal, on which was charged 800 pounds of scrap iron. The succeeding three charges of bituminous coal were 300 pounds each and the fifth, sixth and seventh charges were increased to 325 pounds each. All of the six charges of scrap iron were uniformly 600 pounds. The fuel consumption was 2,525 pounds and the iron charges 4,400 pounds. While the melting ratio still was high, nevertheless the metal was satisfactory for our use. The fact that the slag was exceedingly limited in amount may be attributed to the small ash content of the coal, which was only 4.78 per cent. We have never heard of gray iron being melted with bituminous coal and while the results are not so satisfactory as with coke, nevertheless we have demonstrated that in a *pinch* bituminous coal can be used to advantage in the cupola.

The Properties of Bronzes for Mechanical Purposes

A Discussion of the Influence of Copper, Tin, Zinc and Other Metals Upon the Characteristics of Various Bronze Mixtures

By H S Gulick

A DECADE ago it was estimated that there were in use, for engineering purposes, 330,000,000 pounds of copper base alloys. It is entirely probable that in view of the increase in the amount of machinery and mechanical appliances, some parts of which are made of bronze, that the value of such alloys now in use is in excess of $100,000,000.

In a technical sense the term *bronze* is applied only to an alloy of copper and tin, and while a committee is working on a more accurately descriptive nomenclature for these alloys, common usage has loosely applied the term *bronze* to classify a large number of alloys varying widely in component elements and corresponding properties. These are distinguished from brass, which generally is regarded as primarily an alloy of copper and zinc in fairly definite proportions.

For mechanical purposes, the first class referred to, or the alloys composed chiefly of some combination of copper, tin, lead and zinc, are by far the most important, and with the addition of other elements in minor proportions, such as phosphorus, arsenic, silicon, manganese, aluminum, etc., which give them special properties, the principal alloys of this group will be considered in this paper.

Physical Properties

In general this class of non-ferrous alloys is preferred because they possess in the required degree one, or a combination of the following physical properties: Strength, ductility, malleability, hardness, electrical conductivity, heat conductivity, high specific gravity, density of grain combined with easy machining, anti-frictional qualities, impermeability to gases or liquids, resonance, resistance to corrosion, resistance to oxidation, resistance to mechanical erosion and color and beauty of finish.

While the influence of the different metals composing the bronzes varies somewhat under the different conditions imposed by varying combinations, in general, their effect on the physical properties may be briefly described as follows:

The basic element of all bronze mixtures is copper and it is usually regarded as a softener imparting malleability, ductility, conductivity and toughness. It increases the tensile strength and particularly increases the elongation or ductility. Also, it increases the frictional resistance and hence, if the proportion of copper present is too high, when subjected to fast speeds or heavy pressures, a serious rise in temperature may result. Its specific gravity in the cast form is about 8.8, its tensile strength per square inch is approximately 24,000 pounds, and the compressive strength is about 55,000 pounds. The melting point of copper is 1,986 degrees Fahr.

Importance of Tin

Tin is next in importance since its use in graduated percentages increases the hardness to any degree desired. Corresponding with this decided hardening tendency of tin, the tensile strength is increased and the elongation reduced. It forms a homogeneous mixture with a resultant fine-grained metal, susceptible to heat treatment. It increases the shrinkage in casting and lowers the melting point. The tensile strength of tin is about 4,580 pounds, and the compressive strength is 5,780 pounds per square inch. Its specific gravity is 7.4 and the melting point is 446 degrees Fahr.

Zinc, except in the special, so-called bronzes, wherein the zinc content is very high, is used mainly as a flux. It closes the grain and softens, therefore lowering, the tensile strength, but increases the elongation. Due to this effect and its rather high coefficient of friction, it heats easily under pressure and is undesirable in bearings except in small percentages. In large percentages it is not easily filed or machined. It does not alloy with lead and hence its use should be limited when this element is present. Zinc has a tensile strength of about 6,200 pounds and a compressive strength of about 33,500 pounds per square inch. Its melting point is 786 degrees Fahr.

Lead used in bronzes reduces friction, and hence where two surfaces are in sliding contact, the tendency to overheat is counteracted. With copper, lead contributes a degree of softness which enables compositions, otherwise machined with difficulty, to be readily tooled. Lead does not perfectly alloy with copper, and particularly in large percentages, a homogeneous mixture, necessary for the production of sound castings, requires the use of artificial means to induce a quick setting of the structure. This is sometimes accomplished by the use of the proper percentage of some non-injurious element, having a higher melting point than the bronze or better, by mechanically setting the metal at the time of pour. Unless rapidly cooled in this manner, lead very materially decreases the tensile strength and elongation. The tensile strength of lead is about 1,780 pounds and the compressive strength 3,890 pounds per square inch. The specific gravity is 11.37, and the melting point is 621 degrees Fahr.

Use of Phosphorus

The principal use of phosphorus is as a deoxidizing agent, and since oxygen or its compounds form one of the most serious detriments to the production of sound, strong castings free from blow-holes, and although never existing in the metal, except in small proportions, it is a very important element. Besides acting as a flux, it makes the metal run more freely and helps it to become thoroughly alloyed. Phosphorus when remaining in the metal, acts as a decided hardener, and in consequence of this, the tensile strength is increased and the elongation diminished. Tests have proved that where the percentage of tin in the bronze is low, residual phosphorus increases the rate of wear, but where used in bronzes having a high tin content, the rate of wear is materially decreased. Its specific gravity in the yellow stick form commonly used, is 1.84, and the melting point is 111 degrees Fahr.

Antimony in small percentages is sometimes used as a hardener, and it also yields a close-grained bronze. It rapidly increases the tensile strength and lowers the elongation. Since its conductivity at normal temperatures is

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From a paper read at the November, 1915, meeting of the St. Louis Foundrymen's Club.

only 4.35 it acts as a marked depressant on the conductivity of the few special bronzes in which it is used.

Manganese is used in small proportions as a deoxidizer and hence is an aid to the production of sound castings. When a sufficient quantity of this metal is used, so that residual increments remain in the bronze, the tensile strength is increased. Also, the elongation is reduced, but this reduction is not proportional to the increase in strength, so that a small percentage in a bronze of normal composition acts as a toughener.

Titanium, while acting apparently in much the same way as manganese, is even more powerful in its effect, and hence a solid, strong, tough bronze may be obtained by its judicious use.

Nickel is used in minor percentages in some special bronzes, since it sets quickly, thus aiding to form a dense, close-grained structure and helps to lower the rate of wear.

Iron is usually present in bronzes in small amounts, in some instances merely as an impurity and in other notable bronzes is purposely added. If thoroughly alloyed with the copper it tends to increase the strength and hardness at the expense of elongation.

Commonly Used Bronzes

The most commonly used bronzes, with the variations introduced by different manufacturers, include a wide range of latitude in mechanical properties, and may be summarized under the headings of gun metal bronze, phosphor bronze, steam metal bronze, aluminum bronze, Tobin bronze, manganese bronze, silicon bronze and bearing bronze.

One of the most interesting of the true bronzes, and one largely specified by the United States navy and ordnance departments, is commonly known as gun metal bronze, from the fact that it was formerly largely used for gun castings. It is composed of about 88 per cent copper, 10 per cent tin and 2 per cent zinc. Its tensile strength, normally, is about 35,000 pounds per square inch, with an elongation of about 15½ per cent in 2 inches, and 15 per cent reduction of area.

Even with good practice, however, these physical results are all widely variable and depend in a large measure upon the method of casting the test bar, that is, in the size, shape, weight of riser and rapidity of chilling.

Phosphor bronze is a very important member of this group and is divided into two classes, designated as hard phosphor bronze and soft phosphor bronze. The hard phosphor bronze, usually is composed of about 90 per cent copper, 9.8 per cent tin and 0.2 per cent phosphorus. Normally its average tensile strength is about 33,100 pounds, its elongation 12.5 per cent and reduction of arca, 12 per cent. It resists repeated stresses well, showing little fatigue after undergoing heavy loads. This bronze is used for valves and pumps required for oil refining, and in chemical processes where resistivity to the action of acids is demanded. It also is widely used for general work for which it is well fitted by its high strength combined with ready workability, for it can be rolled, cold drawn and forged, as well as cast. This same bronze, when alloyed with about 0.5 per cent more phosphorus becomes quite hard and is then used for cog and worm wheels, high speed bushings, slide valves, etc.

The soft phosphor bronze is composed of 80 per cent copper, 10 per cent tin and 10 per cent lead. Its normal tensile strength averages 28,000 pounds per square inch; elongation, 5.5 per cent in 8 inches, and the reduction of area on bars of this metal is about 5 per cent. It is used to a large extent as a bearing metal.

Steam bronze usually contains about 85 per cent copper, 5 per cent zinc, 5 per cent lead and 5 per cent tin, although each of these percentages can be varied by 1 to 3 per cent, depending upon the properties which it is desired to accentuate in the bronze. Its tensile strength varies from 26,000 to 32,000 pounds per square inch; elongation from 16 to 22 per cent, and reduction of area from 19 to 25 per cent. As its name implies, it is used for general steam work, that is, for mechanical parts which are used with saturated steam pressures. When correctly made it is a thoroughly reliable and homogeneous metal for all around work, on account of its ductility; furthermore it casts well and takes a good color and finish. It also is largely used for automobile parts.

There are several special bronzes which are coming more and more into general use for specific purposes, as their properties become better known. Of these aluminum bronze, containing 95 per cent copper and 5 per cent aluminum, on account of its great strength and ductility at high temperatures, is excellent.

Its tensile strength normally averages 35,200 pounds, with an average elongation of 56 per cent and an average reduction of area of 47 per cent. One great advantage of this bronze is that even at a temperature of 600 degrees Fahr. the elongation drops only to 45 per cent, and the tensile strength to 24,300 pounds, which is in marked contrast to the other bronzes. On this account it is used for superheated steam valves and fittings. This bronze also is used for seamless tubing, since it can be worked at a bright red heat. It can be rolled, swedged, spun or drawn cold. By increasing the aluminum content to 11 per cent, a tensile strength as high as 100,000 pounds per square inch may be attained with an elongation of 8 per cent.

By the addition of a small percentage of titanium to well made aluminum bronze, a strong, tough bronze is produced, having a tensile strength of 70,600 pounds per square inch; an elongation of 14 per cent and reduction of area of 15.3 per cent. This is said to be excellent for gear blanks and is coming into use for this purpose.

The so-called Tobin bronze is really a brass with bronze properties, since it usually contains about 59 per cent copper, 38.49 per cent zinc, 2.1 per cent tin, 0.10 per cent iron and 0.3 per cent lead.

When cast, its tensile strength is about 66,000 pounds per square inch, with an elongation of from 15 to 20 per cent, and about the same reduction of area. It is practically noncorrosive to sea water and is readily forged at a cherry red heat. It is used largely for pump linings, condensers, rudders, center boards, hull plates for yachts, boiler and condenser tubes and pump piston rods.

Commercial Manganese Bronze

The commercial manganese bronze generally referred to when this term is used, is also a misnomer, in that its principal elements are copper and zinc. By analysis, this contains 57 per cent copper, 41.40 per cent zinc, 1.20 per cent iron, 0.75 per cent tin, 0.50 per cent aluminum and 0.15 per cent manganese. Although different manufacturers vary these percentages slightly, in fact some analyses show no manganese whatever, the small percentage of this element originally added being oxidized out of the bath of metal. However, its physical properties place it in the front rank of bronzes for certain purposes. The tensile strength, when properly alloyed, is not less than 60,000 pounds per square inch, the elongation is not less than 20 per cent and the reduction of area is over 25 per cent.

It is used for automobile shock absorbers, wheel gearing supports and connections of machines, the shells of main and other bearings for engines and sheave wheels, but perhaps the greatest tonnage of this alloy cast is in the form of screw-propellers for steamships and underground hydraulic shapes, where its resistance to corrosion adds to its value for these purposes. Like aluminum bronze, it has a high shrinkage.

Silicon bronze usually contains about 97.3 per cent copper, 1.2 per cent zinc, 1.3 per cent tin and 0.05 per cent of residual silicon. In cast shapes, this bronze has a tensile strength above 50,000 pounds, elongation of approximately 18 per cent and 40 per cent reduction of area. Its principal use is for electrical purposes, where its high conductivity combined with great strength give it an advantage over any other bronze. Also it resists atmospheric corrosion well, and is extensively rolled into telegraph and other wires.

Bearing Bronzes

Bearing bronzes include that very large class of machine bronzes used under widely different conditions of pressure, speed, temperature and corrosion, for bearing purposes, and as might be supposed, this has resulted in the design of numerous compositions. Where only thin sections are permissable and a maximum amount of strength is required as in motor armature and axle bearings, compositions similar to the phosphor bronze previously referred to are used. These often are varied by the addition of nickel and small quantities of a number of other elements. However, on quite a large class of general bearings, the increased wear and anti-frictional properties which lead will impart to a bearing composition, if thoroughly alloyed, cause it to be generally desired to incorporate as large a percentage of this element as casting conditions will permit, and still retain sufficient strength to meet the compressive strains and shocks to which this type of casting is peculiarly subjected in service. Normally, for sand cast bearings, this maximum occurs at about 16 per cent of lead, so that a typical specification for locomotive bearings will require a composition of not less than 75 per cent copper, not less than 8 per cent tin, not less than 10 per cent lead, nor more than 16 per cent, and not more than 3 per cent of zinc and less than 1 per cent of other elements. This metal will stand a deflection about 1 inch on a 1-inch bar with 9-inch supports before fracture, and has a tensile strength of about 21,000 pounds and an elongation of 9 per cent in 2 inches. Special processes of casting, however, admit of the incorporation of lead in percentages as high as 25 to 30 per cent, and still a structure is obtained which is as strong as the normal composition cast in sand.

If, when melted, these alloys can be considered as being solutions of one metal within another, then the phenomena which take place during the solidification and cooling of the solutions naturally affect the resultant properties after solidification. Hence, on account of the many gradations in cause and effect, in modern plants, for the production of high-grade bronzes, and where fixed standards are required to be maintained, the results are checked in four different, but almost equally important ways, namely, by chemical analysis, microscopic examination of structures formed, examination of the phenomena of solidification and fusion, and the physical characteristics of the alloys.

Require Careful Treatment

Almost all metals are easily subject to mistreatment while existing in a fused state at high temperatures, but the bronzes as a class are particularly sensitive to such conditions, and exact the most careful handling in order to obtain the best results. It is possible to melt the same quantities of the same elements together, and get entirely different physical results.

While the careful manufacturer by these methods of metallurgical control can satisfactorily meet nearly any requirement of mechanical practice, yet there remains much room for development in this field. Our knowledge is by no means complete regarding some of the complex changes which occur by slight variation in methods of treatment, so that modern, exacting conditions necessitate a thorough understanding of the general fundamental principles so far established in order to produce and judge high grade bronzes which will economically and efficiently meet the service conditions imposed upon them.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Mixture for Cheap Car Journal Bearings

What is the composition of an alloy used in the cheaper grades of car journal bearings? Can this mixture be changed so that a larger percentage of lead can be employed and would the addition of zinc improve its lead-carrying properties?

In making cheap car journal bearings, any kind of low-grade scrap is desirable. The source of copper usually is scrap copper bottoms, turnings, copper wire, etc., while the other scrap, namely alloyed metals, consists of mixed turnings and miscellaneous light, yellow scrap. A mixture used by one large company consists of scrap copper, 130 pounds; zinc, 60 pounds; lead, 10 pounds, and mixed turnings, 100 pounds. This is the charge for a No. 100 pot. Another mixture consists of such light scrap as clock works and light yellow scrap melted in 1,000-pound lots, which is ingoted and in which process considerable iron is introduced from the iron parts of the scrap. The ingots then are remelted and heavily leaded. The castings obtained from these mixtures were used for solid bearings, as well as for the shell type of car brasses.

An analysis of a good grade of bearing metal follows: Copper, 72 per cent; lead, 10.2 per cent; zinc, 10.3 per cent; tin, 6.7 per cent, and antimony, 0.8 per cent.

Progress in Casting Brass in Permanent Molds

Will you kindly advise us what progress has been made in making small brass castings in metal molds?

Thus far little progress has been made in making brass castings in metal molds. Aluminum bronze is the easiest alloy to cast, since it does not smoke or coat the molds. Also, it is ductile at a red heat, permitting the removal of the castings from the mold without cracking. It does not contract until solid and strong, allowing plenty of time for its removal and when separated hot from the metal mold, it does not appear black and unsightly, the same as red brass. For this reason, aluminum bronze is the only alloy with which progress has been made thus far, although some manganese bronze castings also are being successfully produced. A difficulty, however, with aluminum bronze is that the alloy cannot be modified and cannot be made free cutting by the addition of lead, etc., and its percentage of contraction is high so that only small castings thus far have been made, which do not require much machine work.

Shrinkage Difficulties

We have been having trouble with the formation of gas pockets in small, cup-shaped brass castings. We have made a thorough investigation, but cannot satisfactorily explain the cause of the difficulty. Our mixture consists of the following: 89.4 per cent of a special mixture consisting of 86 per cent copper, 7 per cent tin, 4 per cent zinc and 3 per cent lead; 10 per cent of bronze drillings and 0.16 per cent of delta metal; the latter consists of 57.6 per cent copper, 38.5 per cent zinc, 0.44 per cent lead, 3.53 per cent manganese and 0.08 per cent iron. Can you advise us the cause of our trouble?

The mixture which you are using is entirely satisfactory, although the castings appear to contain more zinc than stated in the formula. Porosity may be caused by carelessness in melting, or it may be inherent in the special mixture, which we assume is ingot metal. You should ascertain the cause of this porosity to enable you to apply the proper remedy. Several of the ingots should be fractured and if the fractured surfaces are clean and homogeneous, the fault is in the foundry; but if the ingots contain red spots, the trouble can be traced to the ingot metal. The so-called gas pocket is not due to porosity, although it is aggravated by this condition. This difficulty is attributable to shrinkage and the way to prevent it is to mold the castings with the other end up, even if the oblong recess has to be cored out. The entire casting, with the exception of the oblong cavity, should be imbedded in the drag half of the mold.

Use of an Excess of Sulphur

When machining castings made from the mixture containing 60 per cent copper and 50 per cent lead, porous spots appear. Will you kindly advise me how to overcome this difficulty?

It is probable that too much sulphur is being used to hold the metals together when solid. We suggest that the percentage of sulphur be reduced gradually until good results are obtained.

Introducing Iron Into Manganese Bronze

What is the best way to introduce iron in manganese bronze? What kind of iron would you advise using and how can it be prevented from forming into small granules or pellets which will not fuse with the metal? When casting small hooks in pure nickel for plating purposes we find it difficult to get the metal to run perfectly. What alloy, if any, would you advise using to increase fluidity, and how much of this alloy should be employed?

Iron usually is introduced in manganese bronze through the medium of a hardener known as *a steel alloy*. Its composition follows: Norway iron, 18 pounds; 80 per cent ferro-manganese, 4 pounds, and tin, 10 pounds. The Norway iron and the ferro-manganese are melted together, while the tin is melted separately. When the molten manganese iron alloy is removed from the fire, the tin is poured into the mass. The alloy then is shotted by pouring it into water. The bronze is made by melting copper, 56 pounds; steel alloy, 2 pounds; zinc, 43 pounds, and aluminum, 0.5 pounds. Considerable skill, however, is required to make this alloy satisfactorily. In casting pure nickel, the only element that will increase fluidity is aluminum in the proportion of about 0.25 per cent.

Effects of Phosphor-Tin and Phosphor Copper

What are the effects of phosphor-tin and phosphor-copper on brass? Is it necessary to use both of these alloys at the same time and what percentage should I employ to insure sound castings of an 88-10-2 mixture? We have received an order for large brass sleeves weighing 800 pounds each, which will necessitate the melting of the mixture in the cupola. How much phosphor-tin and phosphor-copper should be added for each 100 pounds of metal melted? We also would like to know how much scrap can be employed in this mixture, as we would like to charge at least 25 per cent of old metal.

The effects of phosphor-copper and phosphor-tin in bronze are identical, since the copper and tin merely serve as vehicles for the introduction of the phosphorus, which acts as a deoxidizer when used in small amounts. It is not necessary to use both phosphor-copper and phosphor-tin at the same time. Phosphor-tin, however, is recommended when melting metal in a cupola, as it can be placed in the ladle and will dissolve easily when the molten metal is tapped onto it. In the 88-10-2 mixture, the phosphorus must be kept very low, as otherwise the alloy will not be homogeneous and the castings will leak under water pressure. With metal properly melted in the crucible, two ounces of 5 per cent phosphor-tin per 100 pounds of alloy is all that should be used. In cupola-melted metal, use 0.5 per cent of phosphor-tin, which should be placed in the ladle and the metal tapped onto it. The alloy should easily take 25 per cent of scrap of the same composition.

Wire Drawing Blocks

We have been having some trouble with cast iron dies for wire drawing, which we are making in large quantities. The dies are 2½ inches wide, 6 inches long and 1¼ inches in thickness. There are 16 holes in each die, tapered from ½ inch in diameter at the back to a fine point at the front. We have been casting the dies in iron molds, using steel pins to core out the tapered holes. The metal does not run close up to the small ends of the cores, thus making the holes too large. We also have had some trouble in getting the cores or steel pins out of the castings. In some cases the metal is burned fast to the cores. What should we do to avoid these difficulties?

We suggest that the steel pins be protected with a heavy-carbon oil wash, which ought to eliminate the trouble resulting from the molten metal sticking to the pins. These castings are quite difficult to make and it is essential that your mixture be correct and that the iron be poured at the right temperature. Undoubtedly, the molten metal quickly heats the small ends of the cores so hot that they weld to the casting. To avoid this, the cores should be withdrawn from the mold just as soon as possible after pouring. Of course, if the cores are withdrawn too quickly, the die will not be properly chilled. It probably will be necessary to experiment with the problem a little and if it is found that a suitable chill cannot be obtained in any other way, it might be advisable to resort to water-cooled cores.

Trouble With Nickel Anodes

Our nickel anodes are causing us considerable trouble. After two or three weeks' use they begin to have a coarse structure and small particles crumble off like sand. This difficulty occurred when we melted our nickel in a coal furnace and we attributed it to this process. Later we melted the nickel in an oil-fired, reverberatory furnace without using crucibles, but this trouble still persists and we would like to have you assist us by pointing out the remedy. We *desire to produce an anode that will dissolve uniformly, giving a very light deposit of nickel oxide and graphite on the outside of the anode and a smooth, dense surface underneath.*

The cause of granular nickel anodes is rather obscure, although most nickel anode manufacturers have to contend with it from time to time. Some authorities attribute the trouble to the use of too strong a solution and claim that the difficulty is not with the anodes. Instances have occurred where a solution maintained at over 10 degrees Baume has caused difficulties with granular anodes, which ceased entirely with the addition of water, reducing the solution of 7 degrees Baume. It has been claimed that if a solution is saturated, it will not take up the basic salts formed at the anode. However, if the solution is found to be of the proper strength and it is believed that a higher carbon content would improve the anodes, this can be attained by melting the nickel twice in contact with carbon, and if pure nickel anodes (98 per cent nickel) are being used, change to soft or alloyed anodes.

The average composition of 90.92 per cent nickel anodes follows: Nickel, 90 per cent; iron, 6.5 per cent; tin, 3 per cent and carbon, 0.5 per cent. The iron *softens* the anodes and helps it to dissolve uniformly, while the tin makes the composition more fusible. We suggest that this formula be given a trial if some other solution of the difficulty is not discovered.

Deoxidizer for Copper Castings

We are experiencing difficulty with blow-holes in castings which are almost pure copper. Phosphor-copper is used as the deoxidizer, the phosphorus content ranging from 0.07 to 0.18 per cent. We melt a 2,500-pound charge in a cylindrical furnace, using oil for fuel. We would be pleased to have you furnish us with a sand mixture which would give clean castings, free from scabbing, etc.

Phosphorus in the form of phosphor-copper is an unsatisfactory deoxidizer for copper castings, even if high electrical conductivity is not an object, as it causes pitting on the surface of the castings, as well as other difficulties. In its place use silicon in the form of 10 per cent silicon-copper. Use 1 per cent of the latter five minutes before removing the copper from the furnace. Do not use an iron stirrer for mixing the silicon addition. There is no need of a special facing for copper castings made from silicon-treated copper, an open grade of molding sand that will vent freely proving satisfactory for this work. Use large risers to feed the copper as it shrinks.

Analysis of Benedict Metal

We have an inquiry for white bronze castings which are to be made of Benedict metal. Can you give us the mixture of this alloy, which, we understand, contains about 16 per cent nickel, making a white, hard casting?

An analysis of Benedict nickel, or Benedict metal, gave the following results: Copper, 79.37 per cent; nickel, 19.87 per cent, and iron, 0.36 per cent. The normal composition is copper, 80 per cent, and nickel, 20 per cent. It is used for condensers, feed water heaters, evaporator tubes, distillation equipment, etc. The following alloy is recommended: Copper, 64 per cent; nickel, 33 per cent, and aluminum, 3 per cent.

How to Mix and Melt Manganese Bronze

In casting a manganese bronze alloy, which you recommended to give 60,000 pounds tensile strength and 20 to 25 per cent elongation, the best results obtained were 65,000 pounds per square inch and 6 per cent elongation in 3 inches. The metal seemed to be too hard. I reduced 0.5 pound of 80 percent ferro-manganese to pea size, placed it in the bottom of a crucible with 1.5 pounds of iron, the latter consisting of thin strips of No. 26 sheet iron, about 1/16 inch thick, 1½ inches wide, and about 4 inches long. I then charged 56 per cent of copper, covered it with charcoal, taking three pounds to cover it and mixed the charcoal with 1.5 pounds of table salt. A cover was placed on the crucible. When the metal was melted, the cover was removed, the bath stirred well and 0.5 pound of aluminum, 40.5 pounds of zinc and 1 pound of tin were added to the mixture, stirring thoroughly after each addition. The metal was poured into ingots, which were remelted the next day and test bars poured. Kindly advise if the procedure followed is correct and how the required tensile strength and elongation can be obtained?

Probably the most convenient method of making manganese bronze is to employ a hardener which contains the iron, manganese and tin, but your method of procedure also has been employed frequently and has proven successful. In this case it is doubtful whether the iron was properly alloyed, as the strips were entirely too thick. It is advisable to use strips of tin plate and to allow for the costing by reducing the amount of tin to be added from 0.75 to 1 per cent. The purity of the copper plays an important part in obtaining ductility in manganese bronze. It should be free from arsenic and electrolytic copper is preferable for this work. The purity of the zinc is not of such great importance, since lead generally constitutes its greatest impurity and this metal does no harm up to 1 per cent at least, although at one time it was considered essential to use metals free from this element. However, leaded manganese bronze now is being made having a tensile strength of over 70,000 pounds per square inch and 35 per cent elongation and all that is necessary is to obtain the correct mixture. Manganese bronze is not made easily, but the art can be acquired.

In case another formula is preferred, the following is offered: Copper, 56 pounds; zinc, 41.5 per cent; steel alloy, 2 pounds, and aluminum, 0.5 pound. The steel alloy is made by melting 18 pounds of Norway iron with 4 pounds of 80 per cent ferromanganese, to which is added 10 pounds of tin. It is customary to allow 1.5 pounds of zinc extra to compensate for that lost by volatilization. It is not advisable to use too much salt for fluxing purposes and a few ounces would have been better than the 1½ pounds actually used. Too much charcoal also was employed in this case.

White Brass Alloy

Kindly furnish us with a mixture suitable for castings to be used for milking machines, such as valves, pail covers and other parts that come in contact with the milk. These castings should be light, non-corrosive and sanitary and the alloy should either be aluminum-zinc, aluminum-tin or a tin-zinc alloy that will not disintegrate. Would antimony be poisonous when used for this purpose?

For a light alloy the following probably will be satisfactory: Aluminum, 80 per cent, and zinc, 20 per cent. However, the aluminum-tin alloys have little strength. Antimony alone is too brittle to be used for the foregoing purpose, but when it has been combined with tin, it has been used successfully for tableware. Brittania metal is a good instance of such an application. If kept clean, an alloy such as Brittania metal should be satisfactory for this service.

The following mixture is a white brass, such as tin-zinc alloys usually are termed: Tin, 60 per cent; zinc, 38 per cent, and antimony, 2 per cent.

Mixture of No. 31 Aluminum

Kindly let us know the composition of the No. 31 aluminum alloy.

The formula of No. 31 aluminum alloy follows: Aluminum, 81.50 per cent; zinc, 15 per cent; copper, 3 per cent, and manganese, 0.5 per cent.

Removing Traditional Evils of Malleable Practice

Labor-Saving Methods of Charging and Melting Are Made Possible by Novel Air Furnace Used by the American Radiator Co.

WHEN malleable foundrymen are told that a large air furnace can be charged by two men and a craneman, that the laborious skimming of slag may be eliminated, and that the life of brick in the flues can be lengthened considerably by employing a properly designed furnace, they invariably express a sincere doubt as to the possibility of such an achievement. The belief that awkward methods of charging and back-breaking skimming are necessary evils of the malleable industry has become so firmly intrenched, that the mind of the average founder rebels at the thought of a revolutionary change in the operating methods. For that reason, the practice outlined in this article will undoubtedly prove a revelation to many who cling to the old ideas.

The malleable foundry of the American Radiator Co., in which these unusual developments have been made, is the outcome of a determination to broaden the scope of the company's plants to include the manufacture of nipple blanks and other malleable castings required in making radiators and boilers. The first result of this policy was the erection in 1912 of a malleable foundry in Germany. This plant had a daily capacity of 10 tons, and enabled the American company to furnish its European plants with malleable castings at a cost far below that of imported fittings from America, which were subject to high duties. The absence in Europe of black-heart iron, compelled American manufacturers to obtain their malleable requirements from the United States or to erect European plants. The American Radiator Co. and the International Harvester Co. were the first to adopt this method of overcoming the high duties imposed on American-made products.

War Balks Plans in Germany

The German plant was in full operation and a second and much larger one was in the course of construction when the war intervened in August, 1914, necessitating the immediate cessation of activities. With the operation of European factories completely balked, attention was focused upon the erection of a plant in America, and in 1915 ground was broken at Buffalo, for a malleable foundry to supply the radiator and boiler plants in the United States and Canada with malleable fittings. The general building layout and all furnaces, ovens and special equipment were designed by Harry E. Kies, manager of the malleable department, who also built and operated the European plant.

The buildings were designed with a view of getting all of the light and ventilation obtainable in modern foundry construction. Careful consideration was given to the cycle of operations to eliminate unnecessary handling of castings in their movement from one department to another. Special equipment was designed and built to do away with much of the hot and hard work usually found in a malleable plant.

The total floor space, not including the storage sheds, is 81,000 square feet. The roof construction consists of a 32-foot monitor extending east and west through the entire length of the main building. From this monitor, high bays 20 feet wide and 20 feet apart extend to the north and south walls. This arrangement provides for the distribution of light to all parts of the building. The side walls of the monitor and bays are about five feet high, and are equipped with sash pivoted at top and bottom, so that they swing vertically, giving almost a 100 per cent opening for ventilation when desired.

The roof at its highest point in the monitor is 21 feet from the floor, the lowest point on the sides being 19 feet from the floor. This provides ample head room for a five-ton crane which travels the full length of the east and west central bay, and serves the melting furnaces.

Fig. 8 is a plan view of the plant. The molding floors and melting department occupy the main portion of the building, and are separated from

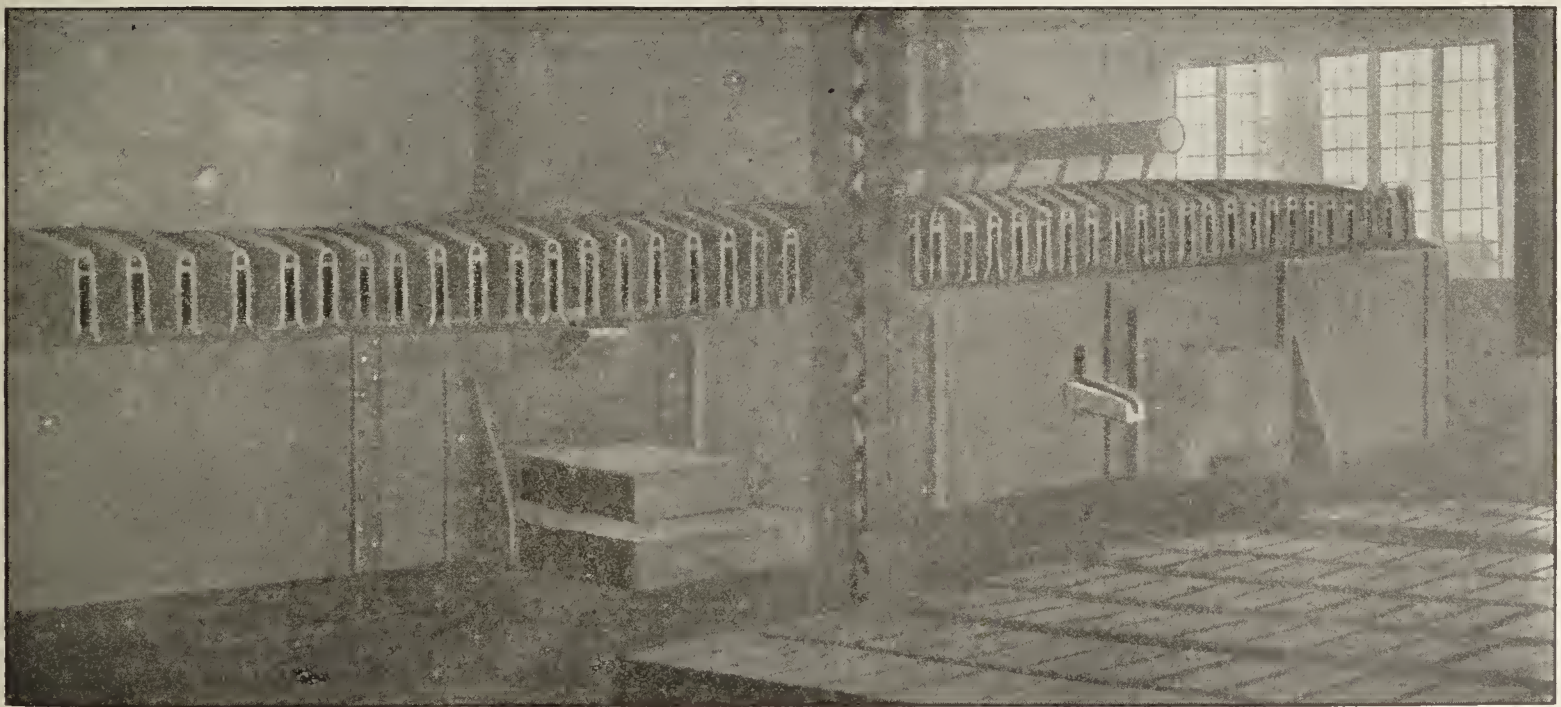

FIG. 1—ONE OF THE 30-TON AIR FURNACES INSTALLED IN THE BUFFALO MALLEABLE FOUNDRY OF THE AMERICAN RADIATOR CO.

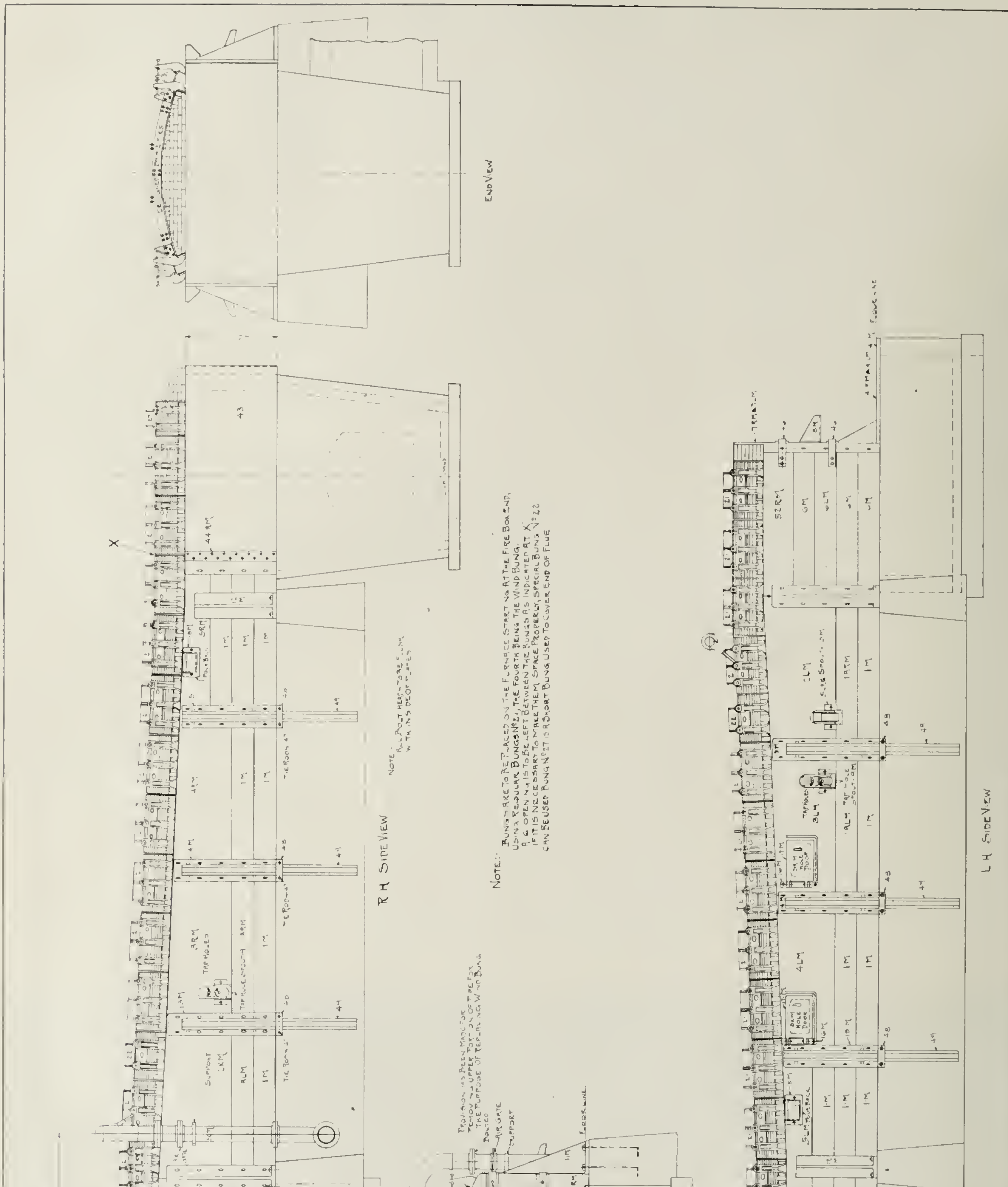
END VIEW
R H SIDE VIEW
L H SIDE VIEW
FRONT VIEW
X
FLOOR LINE
NOTE:-
BUNGS ARE TO BE PLACED ON THE FURNACE STARTING AT THE FIRE BOX END, USING REGULAR BUNGS No 21, THE FOURTH BEING THE WIND BUNG. A 6 OPENING IS TO BE LEFT BETWEEN THE BUNGS AS INDICATED AT X. IF IT IS NECESSARY TO MAKE THEM SPACE PROPERLY, SPECIAL BUNG No 22 CAN BE USED. BUNG No 27 IS A SHORT BUNG USED TO COVER END OF FLUE
TAP HOLES
SUPPORT
TIE RODS
SKIM HOLE DOOR
FIRE HOLE
52 RM
44 RM
44 LM
43
48
49

FIG. 2—ERECTION DRAWING OF 30-TON AIR FURNACE—NOTE THAT A SPACE OF SIX INCHES IS LEFT BETWEEN THE THIRD AND FOURTH BUNGS FROM THE REAR OF THE FURNACE

the cleaning, inspection annealing and shipping departments by four-foot curtain walls, as indicated in the drawing. It will be noted that the castings move in a straight line in passing from the molding floors to the shipping room. This feature has been an important factor in lowering the cost of operation, and since it reduces the amount of labor required for handling castings, it has been an unusually valuable asset in these times of labor scarcity.

Construction of Buildings

The main building, as well as the auxiliary buildings are of steel concrete and brick construction with three-inch booktile roofs. The molding floor is of red brick with the exception of the area near the furnaces, which is of clay. The cleaning, inspection and annealing departments are equipped with hexagon wood block floors. The core room, pattern shop and pattern storage room, locker room and shipping department have concrete floors. The floor line is 24 inches above the rails of the railroad sidings.

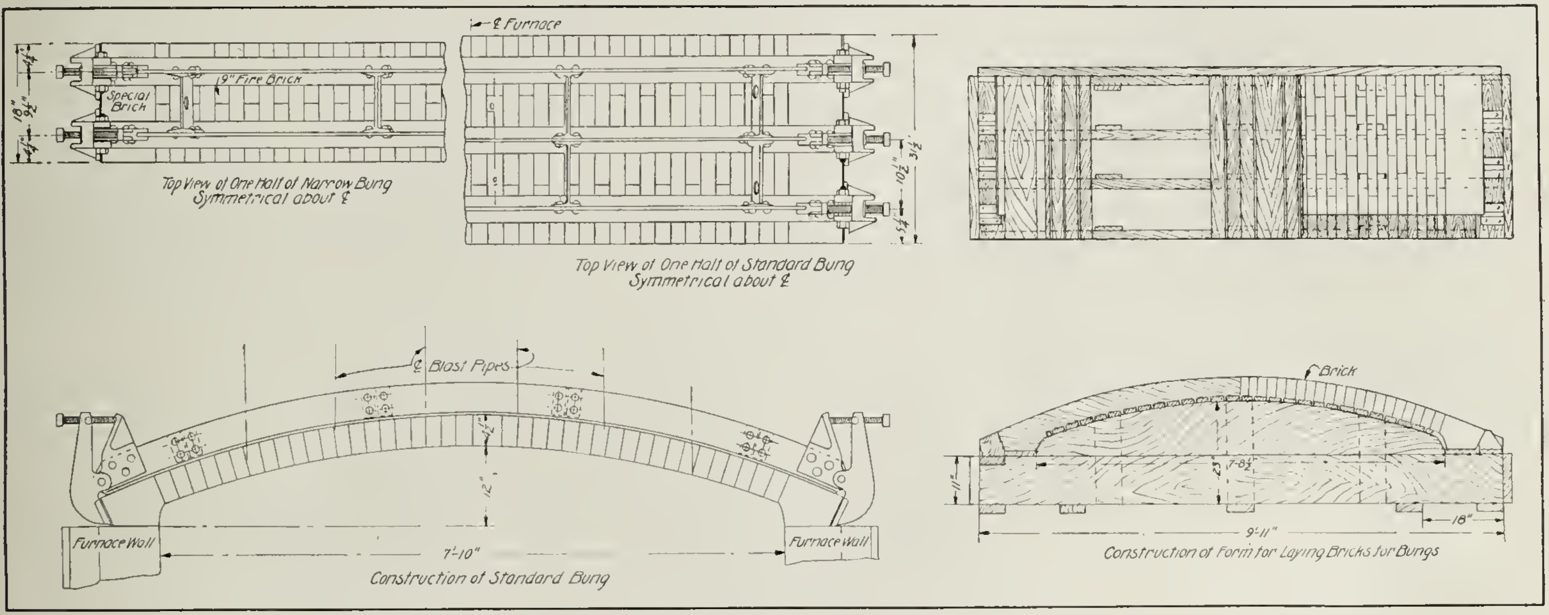
℄ Furnace
9" Fire Brick
Special Brick
Top View of One Half of Narrow Bung Symmetrical about ℄
Top View of One Half of Standard Bung Symmetrical about ℄
℄ Blast Pipes
Furnace Wall
Furnace Wall
7'-10"
Construction of Standard Bung
Brick
7'-8½"
9'-11"
18"
Construction of Form for Laying Bricks for Bungs

FIG. 3—DRAWING SHOWING METHOD OF BUILDING-UP BUNGS FOR 30-TON AIR FURNACE

The most notable feature of this malleable foundry is the design of the melting equipment, which consists of three 30-ton air furnaces. These furnaces differ from the common type in that all air piping and discharge flues are under the molding floor of the foundry, permitting a clear runway over the furnace for a charging crane. One furnace is held in reserve, enabling repair work to be done during working hours.

Fig. 2 is an erection drawing of one of the furnaces. The over-all dimensions are approximately as follows: Width, 10 feet six inches; length, 45 feet; height above floor line (front), seven feet, (back), six feet. The furnaces are arranged in groups of two, the third furnace now installed being the first of a second group to be completed when the volume of business necessitates a fourth unit. The furnaces of each group are laid out so that the rear walls are about seven feet apart, and the flues are laid parallel from the furnaces to a common stack, as shown in Fig. 8. The air pipes lead from a Sturtevant fan in a corner of the core room, under the molding floor to a point near the fire box of each furnace where the pipes divide, part of the blast going into the ash pit and the other part being carried to six distributing nozzles over the wind bung. The pipe leading to the blast nozzles is equipped with an air gate and has a bolted joint which provides an easy means of disconnecting and removing the pipe whenever it is necessary to change or repair the wind bung.

Coal is supplied to the firebox through three fire doors at a height of about three feet from the floor line. The center line of the wind pipe is about nine feet from the fire box end of the furnace and the nozzles enter the bung at an angle of about 45 degrees. Tap hole spouts and pour-back basins are provided on both sides of the furnace, and a slag spout, and two skim-hole doors are on the left-hand side. Each tap-hole spout is arranged for two tap-holes, one above the other, enabling the furnaceman to draw off the hottest iron first.

Design of Bungs

The bungs used on this type of furnace are unusual in that they are made up of 3½ courses of brick instead of one, as in common practice. Fig. 3 clearly shows how this type of bung is constructed. Many failures of bungs are caused by the deterioration of a single brick which loosens the other bricks in the arch and causes a cave-in. These wide bungs having three full courses of brick instead of one, eliminate this trouble, and unless three bricks in the same tier give way, the arch cannot become loosened. The gradual shrinkage of fire brick, which is characteristic of all bungs, is compensated in this design by adjusting screws which take up the contraction of the brick from time to time.

Design Aids Charging

The heavy type of bung aids materially in charging the furnaces, as the craneman has only one-third the number of bungs to handle as in the case of furnaces whose bungs are made up of a single course of fire brick. Charges are made up in rectangular-shaped boxes equipped with a simple tripping device which allows the charge to pass out through the bottom. Each charging box contains about 4,000 pounds, and is easily handled by the five-ton crane already mentioned. The craneman with the assistance of two floor men can easily charge one of the 30-ton furnaces, and this feature is one of the best recommendations for the efficiency of the method of charging permitted by this design of furnace.

It will be noted in Fig. 2 that a space of six inches is left between the third and fourth bungs from the rear of the furnace. This arrangement serves as a damper, just behind the rear bridge wall, and so effectively cools the hot gases that second-grade fire brick is used in the flues with satisfactory results. Moreover, none of the bungs back of this air space have ever been renewed, showing that the six-inch air space actually performs its function in a remarkably efficient manner.

The side walls at the rear of this furnace differ from those of the com-

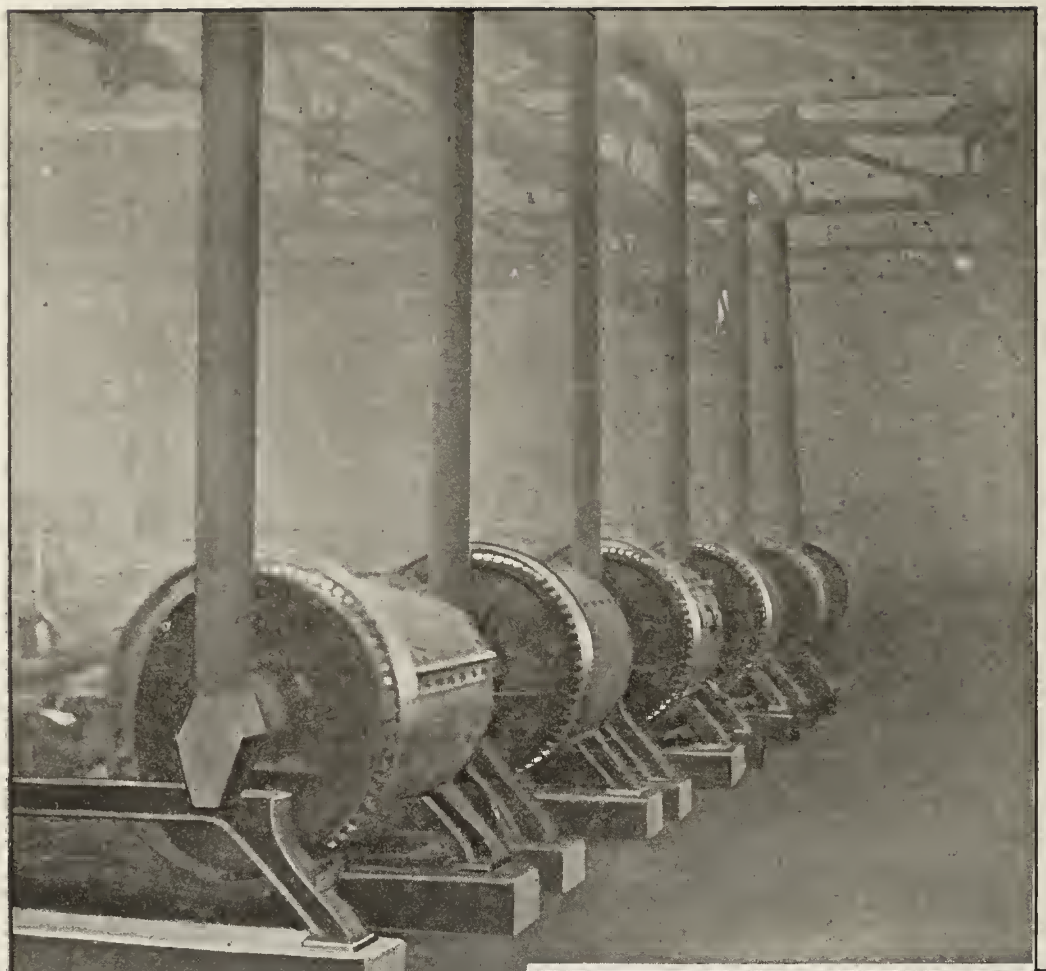

FIG. 4—A VIEW IN THE HARD IRON CLEANING DEPARTMENT

mon type. It has been the customary practice to taper them down to a contracted flue, thereby narrowing the furnace very materially at the back bridge wall. In this particular furnace the walls are parallel from front to rear, and it is believed that this arrangement has had a beneficial influence on the life of the fire brick in the side walls and flues.

Skimming is Eliminated

In operating the furnace, a number of hide-bound foundry rules, deeply rooted in the traditions of the malleable industry, have been completely ignored. The most notable exception to accepted practice is the method of handling the slag. Instead of skimming it from the surface of the iron, it is allowed to remain in the furnace until all of the iron is poured, when it is drawn off through the slag spout. When the slag has been run onto the floor of the foundry, the bottom of the furnace is practically clean, and there is no accumulation of cold slag to be removed before the charge for the next heat can be put in. Moreover, the loss of iron accompanying skimming is avoided. Under this method of operation the ratio of melt to fuel charge is 3 to 1, based on the figures covering operation for a period of one year. A heat of 30 tons can be melted in from 10 to 12 hours.

Advantage of Slag Covering

Naturally this method of operation raises a question as to the part played by the blanket of slag over the iron. Many founders claim that the melting efficiency must be reduced because of the resistance offered by the slag. Sponsors for the new type of furnace admit the truth of this claim, but insist that whatever heat is lost in penetrating the layer of slag is compensated by the advantages of this covering. One of the greatest factors in favor of the new practice is the elimination of heat losses due to the frequent opening of the skim doors of furnaces of the common type. Much of the heat imparted to the metal in an air furnace is due to radiation from the walls of the furnace. When the

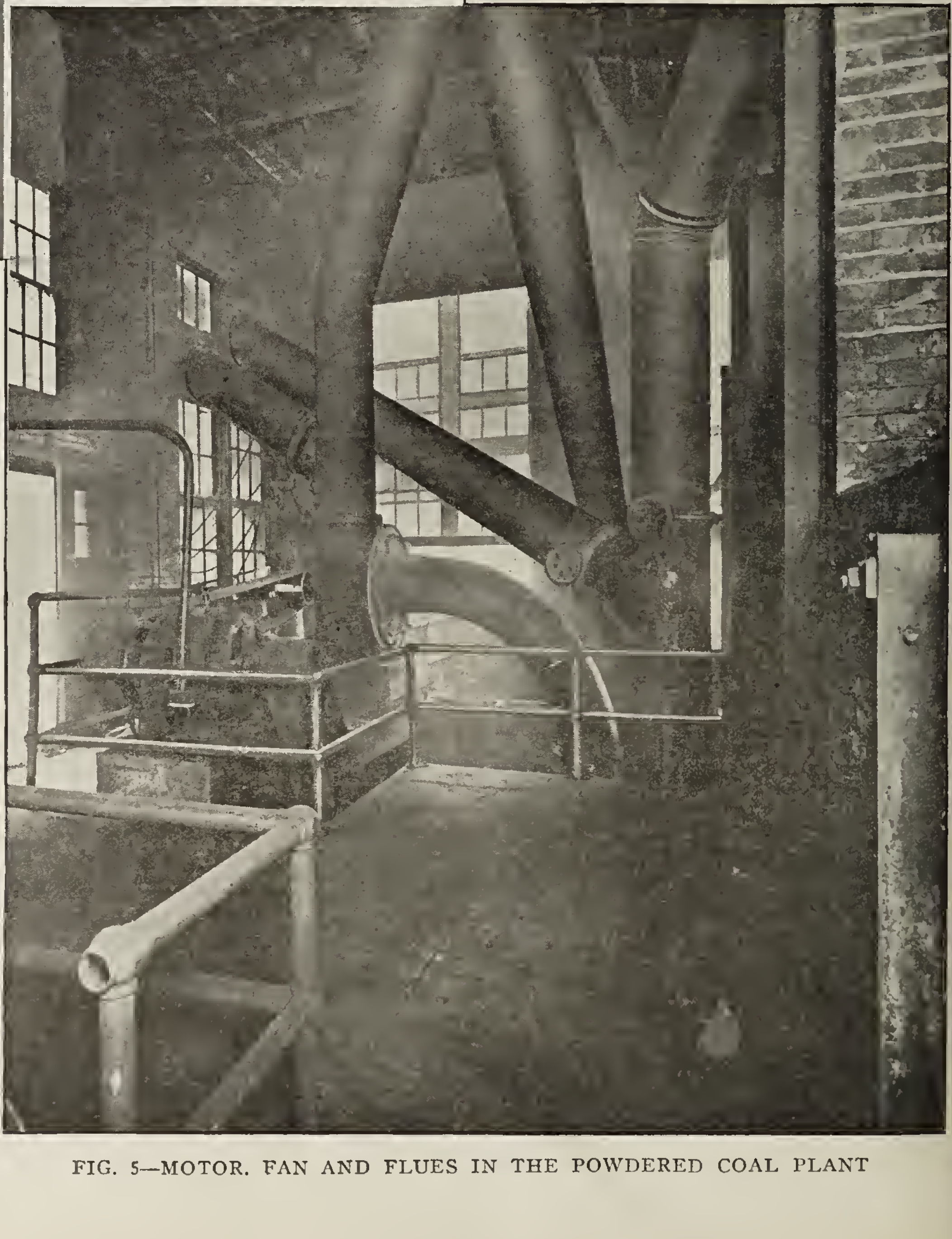

FIG. 5—MOTOR, FAN AND FLUES IN THE POWDERED COAL PLANT

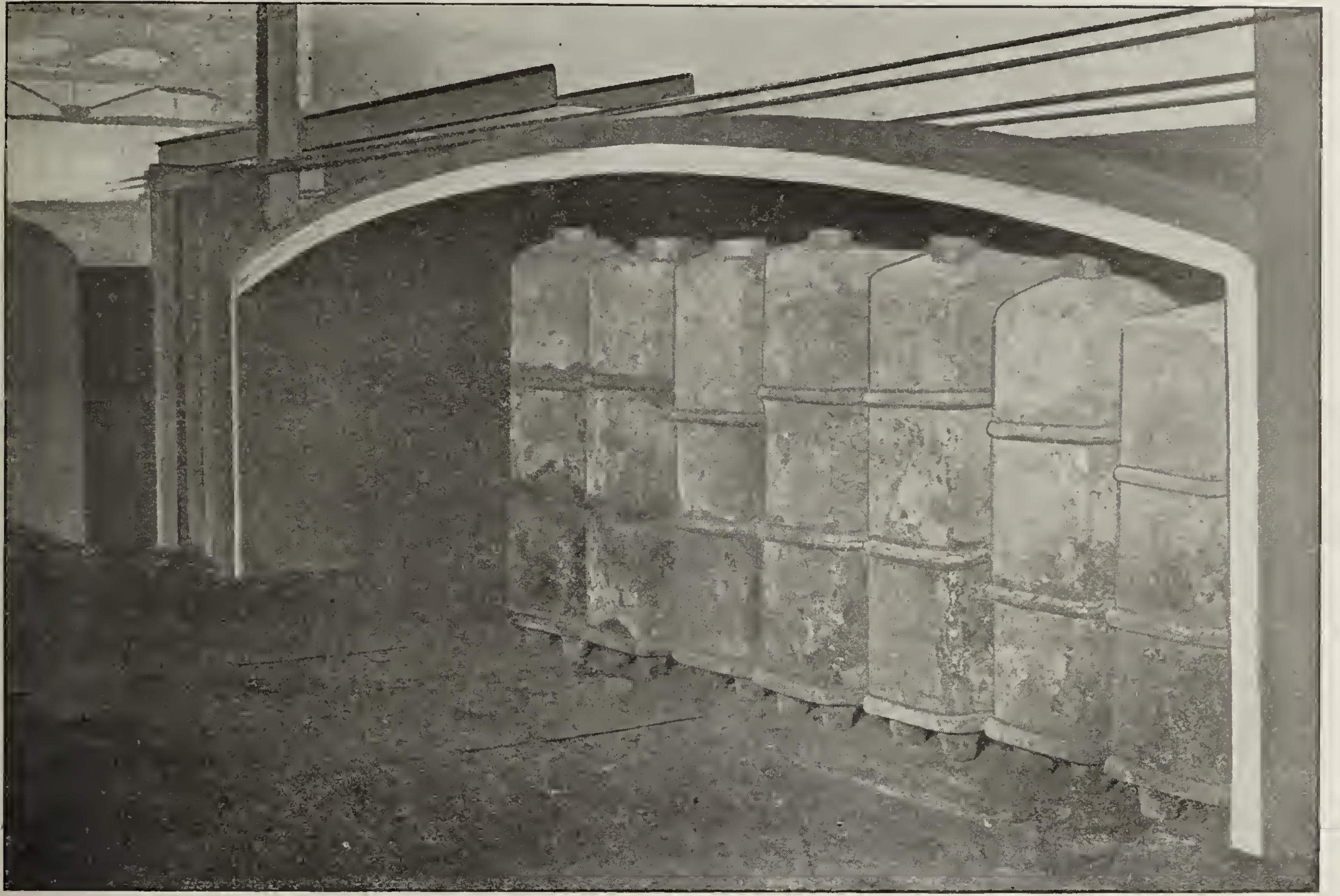

FIG. 6—ONE OF THE LARGE ANNEALING OVENS SHOWING ANNEALING POTS—POWDERED COAL IS USED FOR FUEL

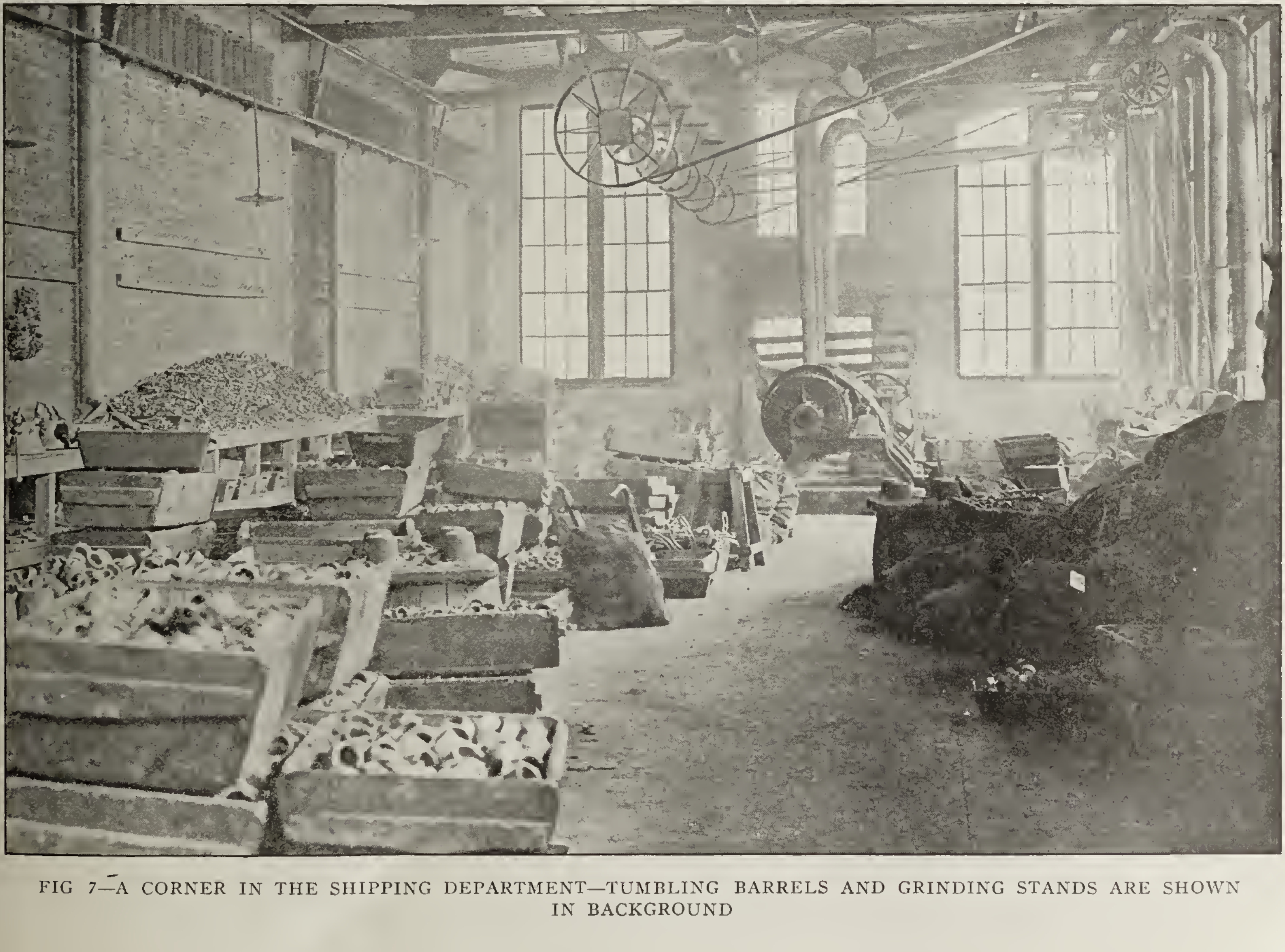

FIG 7—A CORNER IN THE SHIPPING DEPARTMENT—TUMBLING BARRELS AND GRINDING STANDS ARE SHOWN IN BACKGROUND

skim doors are open, heat is absorbed instead of radiated, and the heat loss chargeable to this cause is even greater than that due to the resistance of the layer of slag, according to the belief of persons who favor the new method of handling the slag.

Another advantage of the slag covering is its ability to hold the heat after it is ready to tap, without materially changing the analysis of the iron. This is sometimes occasioned when there are not a sufficient number of molds on the floor for the heat, making it necessary to allow the molders more time for preparing molds. On several occasions heats have been held for several hours, and the fact that the iron was in perfect condition when it was poured is thought to be due to the slag.

Fig. 1 is a view of furnace No. 1, taken just before the heat was tapped. The air space near the rear of the furnace is clearly shown, and the absence of overhead flues is noticeable. The box-shaped projection at the right of the tapping spout is a bank of sand enclosing the slag spout. This is a safety precaution, and absolutely prevents the accidental flow of slag from the furnace. The metal casing over this sand is removed just before the last iron is run off, and after the sand is pushed out of the way, the hole is tapped in the usual way.

Most of the molding is done on hand and power squeezers, while a number of different castings are molded on benches. After the castings are shaken-out, they are taken to the hard iron cleaning room, which is adjacent to the moldng floors. The equipment in this department consists of two sand-blast barrels and dust collecting apparatus, and six tumbling barrels, shown in Fig. 4, which is a view of part of the cleaning room. Only a few feet from the line of tumbling barrels is a row of inspection benches. Every casting is inspected before it is annealed. When it is considered that 75,000 nipple blanks and 20 tons of general castings are made each day, and that these pieces range in weight from less than one ounce up to several pounds, it will be realized that the inspection is an important feature of foundry work.

The inspected castings pass to the floor of the annealing department. Here a novel device has been introduced to enable the men to pack the castings in annealing pots more carefully. In many malleable plants it is customary to pile annealing pots three or four high, and it is impossible for the men to use much care in packing the third or fourth pot, because they are so high from the floor that castings cannot be conveniently placed in them. This trouble has been eliminated by using hydraulic lifts or elevators which enable the workmen to adjust the height of the pots to their convenience. This simple device has removed much of the back-breaking work formerly connected with this operation and has resulted in better castings, for the packing can be performed much more carefully under the improved conditions.

The annealing ovens are arranged in a line at the south of the large room in the main building. The walls of each oven have an air space of 4½ inches between the course of brick for insulating purposes. The doors are of the same construction and

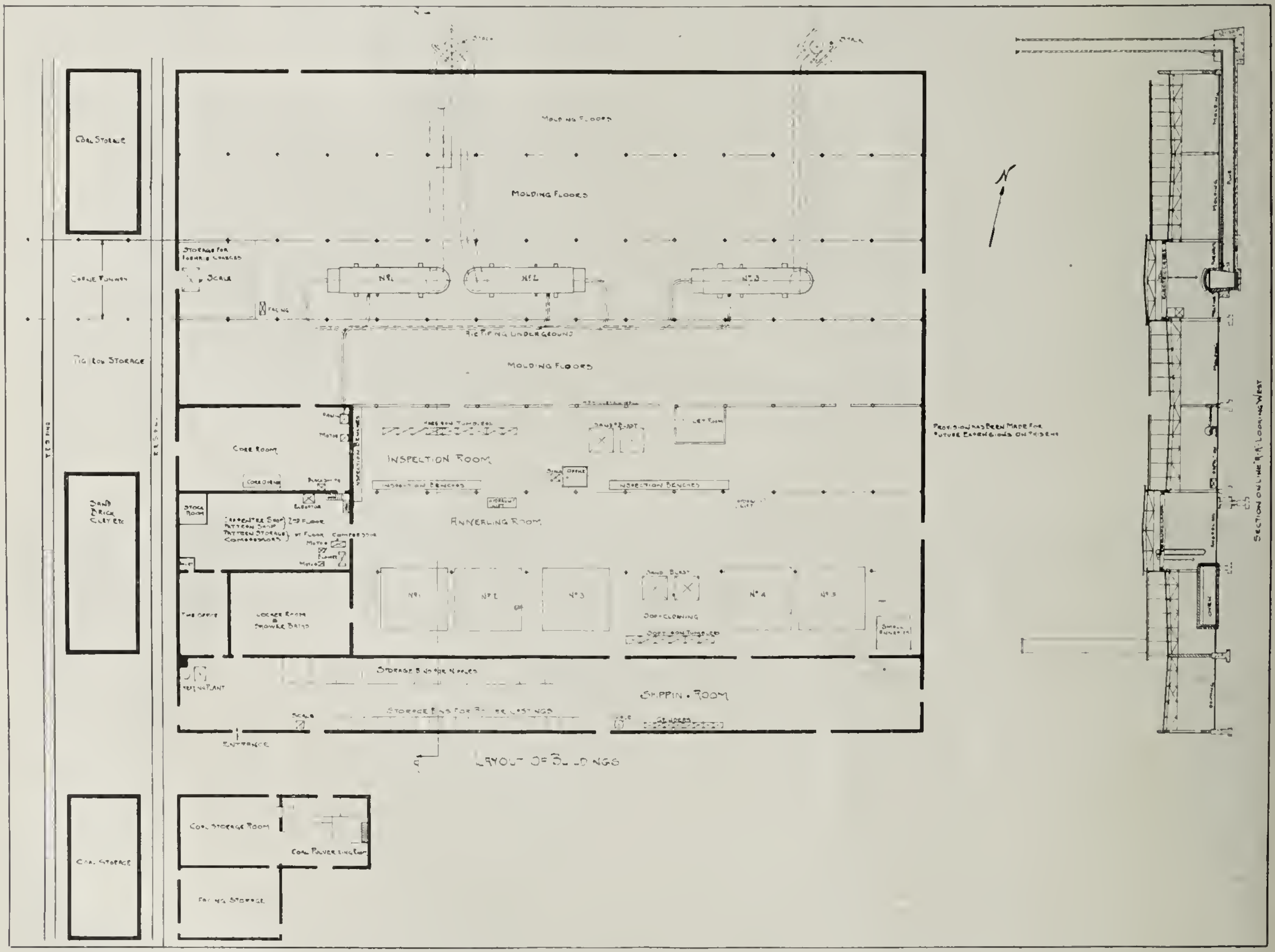

FIG. 8—PLAN VIEW OF MALLEABLE FOUNDRY SHOWING ARRANGEMENT OF DIFFERENT DEPARTMENTS TO FACILITATE THE MOVEMENT OF CASTINGS

are handled by means of an electric crane. The annealing pots are placed in the furnace by a steam-driven charging machine. One of the ovens is shown in Fig. 6.

The annealing ovens are heated by powdered coal delivered to the annealing room through flues from a pulverizing plant. Fig. 5 is a view of one corner of the pulverizing plant showing the fan and motor which furnishes the blast for carrying the powdered fuel to the storage bins over the annealing ovens. Dry coal is fed directly to the grinding mill, while moist coal passes through a coal-fired drying apparatus and then into the grinder. Suction from a fan draws the fine particles of coal up into the flues and carries them into large rectangular receptacles over the annealing ovens. A blast of air carries the fuel from these bins into burners at the rear of the ovens.

The coal pulverizing plant has a capacity of 5½ tons per hour and reduces the fuel to a fineness of 85 per cent through a 200 mesh. In addition to the powdered coal for fuel purposes several thousand tons of facing is packed in bags and delivered to the various plants of the American Radiator Co. each year.

A small annealing oven which was first built for experimental purposes has proved of unusual value in expediting the movement of special orders through the shop. The time required for annealing castings in the large ovens is approximately seven days, while a period of three days is sufficient in the small furnace. This feature of the American malleable plant enables the company to turn out finished castings in record-breaking time when its customers are hard pressed for malleable products.

The soft iron cleaning department is equipped similarly to the hard iron department. A battery of double-stand grinders occupies the southeast corner of the shipping room. Fig. 7 shows a corner of the soft iron cleaning and inspection room.

Sorting Castings

The sorting of the castings is accomplished by selecting pieces of the same pattern from a long bench of cleaned castings and throwing them into rectangular boxes placed at convenient intervals on the floor. A bench of unsorted castings is shown at the left in Fig. 7. Every effort is made to reduce the number of different kinds of castings in each heat, but in spite of this precaution, a large variety of pieces always remain to be assorted.

The shipping room, which runs the full width of the main building also has storage facilities for 1,000 tons of nipple blanks and other castings for the American Radiator Co. In addition to making malleable fittings for this company, job work for many other manufacturers is produced. The average weight of the castings is 0.44 pound, and the product consists of all kinds of automobile castings, wrenches, washing machine parts, and shelf hardware.

Auxiliary departments which contribute to the general efficiency of the foundry are a pattern shop, core room, pattern storage room, carpenter shop, and forge shop. Separate lockers are provided for each workman and shower baths have been installed. The offices are situated in the southwest corner of the building.

Laboratory Facilities Offered

The extensive laboratories of the American Radiator Co., located in the department of thermal research, are within a few hundred feet of the foundry, and offer a service rarely at the command of a malleable plant. A sample of iron from every heat is analyzed and tested, and a record of tensile strength, elongation, ductility, etc., is kept. These records are carefully filed, and the data regarding any particular heat are always available.

A Bright Smooth Surface on Castings

By W. J. Keep

Question:—What process would you recommend to improve the appearance of gray iron castings on a job similar to a step door on a safe? We have been using a good grade of plumbago on these straight faces, yet the sand seems to burn on and it requires extra labor to obtain a smooth job.

Answer:—Increase the silicon. If you make it 3 per cent you will find that graphite will form on the surface of the casting between the iron and the sand, which will cause the sand to peel off. The thinner you make the casting, if the silicon is high, the brighter the casting will be. The thin castings will not have enough weight to burn the sand onto them. For a smooth casting, you should use fine sand, such as is employed for stove plate.

According to the Bureau of Foreign and Domestic Commerce the imports of all forms of unmanufactured copper for the first 10 months of 1916 amounted to 397,594,000 pounds. This compares with an import of 265,677,000 the first 10 months of the previous year. The imports of pigs, ingots, bars, plates, sheets, rods, wire, etc., for the first 10 months of 1916 amounted to 655,472,000 pounds, compared with an import for the first 10 months of 1915 of 529,286,000 pounds.

Making Aluminum Match Plates

By H. Adam

In the past 12 months we made about 300 aluminum match-plates for our warm air heating furnace patterns. We were novices in this work and consequently experienced quite a little trouble before we obtained good results. The problem of shrinkage was the most important obstacle we encountered. We had but little trouble in providing for shrinkage on plates where the patterns were of uniform thickness; in such cases we usually made a white metal pattern with a plaster-of-paris follow-board and after the plaster had set, we sawed the pattern and the follow-board in several places and in this way *stretched* the pattern to take up the shrinkage of the plate when made of aluminum; this shrinkage averaged approximately 3/16 inch to the foot when we employed a mixture corresponding to No. 12 alloy.

Ordinarily, when making plates that had heavy sections, we could provide for shrinkage by using risers over the heavy parts or by using a core; this was not always satisfactory since the core must necessarily extend through the plate to allow the gas to escape. Sometimes a heavy place in a plate may be chilled enough by setting a few nails or spikes in the drag over the heavy part.

When we tried to put a triangle grate bar, such as used in hard coal heating furnaces, on a plate, we found that we could not get enough risers on the teeth of the grate to keep either the teeth or the bar itself from shrinking.

After a number of unsuccessful attempts, we tried a piece of ⅜-inch, round cold rolled steel, anchored in the mold extending the entire length of the bar over the teeth after which a riser was placed on every other tooth. This process cooled the heavy parts sufficiently to allow the plate to shrink uniformly and our troubles were over. We have made quite a number of plates in this way and the method is entirely satisfactory. The difference in weight is scarcely noticeable.

We also experienced considerable difficulty in preventing plates from warping out of shape in cases where the pattern was curved in the shape of a semicircle and heavy in weight. This was overcome by casting ribs on both of the long sides of the plate in the drag; these ribs were ¼ inch thick and 1½ inches deep. When the plate was cold, the ribs were easily removed and the plates were straight.

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Contents

	PAGE
DESIGNING A MODERN FOUNDRY OF MODERATE SIZE	43
TO REDUCE COMBINED CARBON	47
PATTERN SHOP AND FOUNDRY ORGANIZATION	48
REMELTING SHOT IRON	52
THE PROPERTIES OF SEMI-STEEL CASTINGS	53
SAFETY IN THE PLATING ROOM	58
CASTING STEEL WHEELS FOR MOTOR TRUCKS	61
MELTING IN A CUPOLA WITH BITUMINOUS COAL	67
THE PROPERTIES OF BRONZES FOR MECHANICAL PURPOSES	68
PROBLEMS OF THE BRASS FOUNDER	70
MIXTURE FOR CHEAP CAR JOURNAL BEARINGS	70
PROGRESS IN CASTING BRASS IN PERMANENT MOLDS	70
SHRINKAGE DIFFICULTIES	71
USES OF AN EXCESS OF SULPHUR	71
INTRODUCING IRON INTO MANGANESE BRONZE	71
EFFECTS OF PHOSPHOR-TIN AND PHOSPHOR-COPPER	71
WIRE DRAWING BLOCKS	71
TROUBLE WITH NICKEL ANODES	71
DEOXIDIZER FOR COPPER CASTINGS	72
ANALYSIS OF BENEDICT METAL	72
HOW TO MIX AND MELT MANGANESE BRONZE	72
WHITE BRASS ALLOY	72
MIXTURE OF NO. 31 ALUMINUM	72
OVERCOMING TRADITIONAL EVILS OF MALLEABLE PRACTICE	73
A BRIGHT SMOOTH SURFACE ON CASTINGS	79
MAKING ALUMINUM MATCH PLATES	79
THE OPEN-DOOR POLICY IS BEST	80
TRADE OUTLOOK	80
WHAT THE FOUNDRIES ARE DOING	83

The Open-Door Policy is Best

FOR many years a barrier of secrecy, fully as effective as the famed wall of China, has surrounded the details of malleable foundry practice. Only occasionally, have the guarded gates been opened permitting progressive men to sparingly divulge the secrets of the trade. While the facts concerning new developments in steel and gray iron foundries have been circulated for the benefit of these industries, the dissemination of information on the production of white iron has been frowned upon.

Why is this inherent hostility to publicity? Why is this failure to recognize the unlimited possibilities of co-operation? Can it be lack of progressiveness? Look at the proposition from the standpoint of future business for every maker of malleable castings. Isn't it a fact that the very basis of the industry lies in the willingness of manufacturers to use malleable castings? This being true, isn't it of prime importance that every development which enables the foundryman to make better castings at reduced cost should be utilized to its fullest extent in proving to consumers of castings that malleable iron is the best for their requirements? Such a policy has for its goal the creating of a greater demand for malleable products, and demand is the backbone of business. Two heads are better than one, and by the same token, the malleable plants in the United States and Canada, by pooling their experience can develop better methods than any one of them unassisted. Once the quality is improved and cost of production lowered, malleable products will be in stronger demand. An important departure from malleable foundry practice is outlined in an article on page 73 of this issue. The methods described undoubtedly constitute the first important development the industry has witnessed in a period of many years. If the spirit of co-operation, which prompted the men whose ideas have been discussed in this article to offer the results of their experience to the trade, is made part of the policy of every white-iron plant in the country, the malleable industry need not be concerned over the volume of after-war business.

Trade Outlook

LABOR troubles which were a feature of the foundry business during the summer of 1916 have given way to serious transportation difficulties that, at times, threaten to throttle the production of casting plants. Delayed shipments of necessary raw materials, besides hampering the operation of melting equipment to a great extent have made it necessary in some instances for foundrymen to resort to the use of inferior grades of fuel and iron, making the production of first class castings a matter of more than usual difficulty. Prices continue to seek higher levels. Foundry coke quotations fluctuate between wide limits depending largely upon the supply of cars and the labor situation in the Connellsville region. No. 2 pig iron is held, in the leading trade centers, as follows: Pittsburgh, $31.95; Chicago, $31; Cleveland, $30; Buffalo, $30; Birmingham, $23, and Philadelphia, $30. Malleable foundry iron is quoted at $31, Chicago and valley, and $35 at Buffalo. Lake Superior charcoal is in heavy demand at $33.75, Chicago. Spot Connellsville foundry coke is held at $10 to $11.

Foundrymen's Convention and Exhibition to be Held at Boston

The annual convention of the American Foundrymen's Association will be held at Boston during the week of Sept. 24. Concurrent with this meeting will be conducted an exhibition of foundry equipment and supplies, machine tools and accessories in the Mechanics building, which affords an exhibition floor area of approximately 80,000 square feet. This is the second time in the history of the American Foundrymen's Association that it has selected New England for its meeting place, the previous convention having been held at Boston in 1902. At that time the membership of the American Foundrymen's Association was only a few hundred, whereas at present the enrollment is considerably over 1,000. In addition to the meeting of the American Foundrymen's Association, the American Institute of Metals will hold its annual convention at the same time and place.

Personals

Andrew Bryson has resigned as president of the Brylgon Steel Casting Co., New Castle, Del., and has severed his connection with that company.

H. D. Gumpper, until recently associated with the Emerson Co., efficiency engineers, now is connected with the Buda Co., Chicago, in the electric truck sales department.

E. J. Morrow has resigned as manager of the Electric City Foundry Co., Schenectady, N. Y., and has accepted the appointment of foundry manager of the Metals Production Equipment Co., Springfield, Mass.

Frank H. Dodge, formerly affiliated with the S. Obermayer Co., Chicago, in the capacity of resident manager at Cleveland, has been appointed resident manager of the Werner G. Smith Co., Cleveland, manufacturer of oil core binders. Mr. Dodge will represent this company in the state of Michigan and part of Ohio.

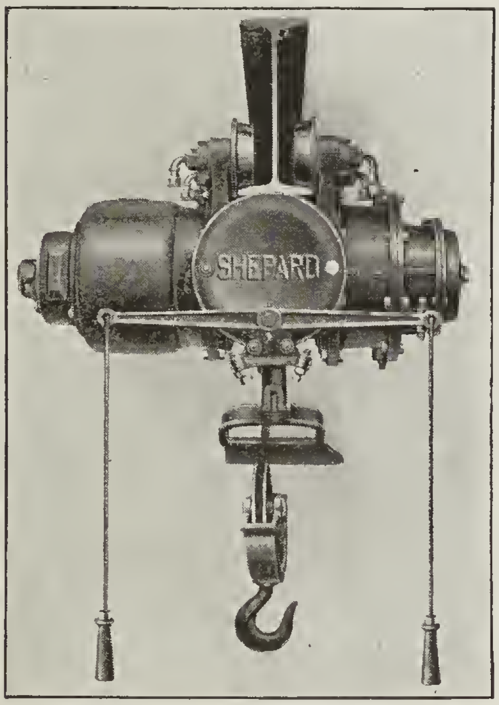
Charles T. Bird formerly connected with the Pangborn Corporation, Hagerstown, Md., as sales engineer and who during the past year was affiliated with the Mott Sand-Blast Co., resigned Jan. 1 to again become associated with the Pangborn Corporation in the capacity of vice president and works manager in charge of engineering and production.

R. A. Bull, who recently resigned as production manager of the Commonwealth Steel Co., Granite City, Ill., has been elected vice president and general manager of the Chicago Steel Foundry Co., Chicago. Mr. Bull will assume his new duties Feb. 1.

As a steel casting manufacturer, Mr. Bull takes rank among the leaders in the industry. For two years he was president of the American Foundrymen's Association and during his leadership this organization had a tremendous growth, both in membership and prestige.

Small Electric Hoists for Foundries

Acute shortages of labor accompanied by an unusual volume of manufactured products in American plants has emphasized the importance of efficient methods of handling materials. The original conception of handling by which comparatively light articles were grouped to form lots of one ton or more has gradually been modified until individual pieces which may be lifted and carried by hand are in many cases preferably handled one at a time by hoists of small capacity.



ELECTRIC HOIST FOR LIGHT LOADS

To meet this demand the Shepard Crane & Hoist Co., Montour Falls, N. Y., has developed a line of electric hoists having capacities of 500, 1,000 and 2,000 pounds. These hoists are operated from a direct-current circuit or from multi-phase alternating current circuits, thus extending their use to a variety of purposes. The hoists are similar to those of larger sizes which have been made by the Shepard company for a period of 13 years except that a sectionalized construction has been employed. The hoist proper consists of four parts or sections, namely, the winding mechanism which is the center section, the motor end, and gear and brake end and controler. Each section is a complete unit by itself and may be employed in any one of a variety of combinations. The sections are merely bolted together to form a complete machine.

A combined mechanical and electrical brake has been developed to enable the hoist to sustain overloads with an ample factor of safety. This device automatically regulates the braking effect to exactly the requirements of the load being lowered. When there is no load on the hook the hoist lowers with the brake completely released. The brake details are designed with a view of reducing heating and wear to a minimum.

The first hoists of this type which were manufactured were equipped with single speed control only, but a controler affording a large number of running speeds and improved control will be available in hoisting equipment manufactured by the Shepard company after the first few months of 1917.

Ferro-Manganese in 1916

Preliminary estimates made by the United States Geological Survey show that the production of manganese ore in 1916 was about 27,000 tons, which was nearly three times as great as that mined in 1915, when the output was a total of 9,709 tons. The prices paid for manganese ore adapted to the manufacture of ferro-manganese advanced from a maximum of $22.50 for 50 per cent ore in 1915 to $32.50 in March, 1916. Imports of manganese ore for the first 10 months of 1916 amounted to 495,299 tons, of which 401,177 tons came from Brazil. For the same period of 1915 Brazil supplied 181,258 tons out of a total of 192,286 tons. Imports of ferro-manganese for the first 11 months of 1916 were 73,435 tons, which is nearly 50 per cent more than for the corresponding period of 1915. Prices reached the highest figures ever recorded in the United States in April last year, when it was reported that $400 a ton was paid for a small lot for immediate delivery. For the remainder of the year the price declined steadily to $160 a ton in October, then rose to $175 again in December. The price of spiegeleisen carrying 20 per cent of manganese ranged from a maximum of $52 in July to $40 in December.

Electric Furnace Installations

The Snyder Electric Furnace Co., Chicago, recently has closed a number of contracts for the installation of its furnaces, including two for the Haynes Stellite Co., Kokomo, Ind., manufacturer of high-speed alloy. One furnace was installed early in 1916. Since the first of the year additional contracts have been placed for three Snyder electric furnaces, which will make a total of six for this company. The Pelton Steel Co., Milwaukee, has placed a contract for an additional electric furnace having a daily output of 14 tons of steel for casting purposes. The New London Ship & Engine Co., Groton, Conn., has purchased an electric furnace which will have an output of 14 tons daily, the metal to be used in the manufacture of castings for the submarine equipment made by this company. The Pratt & Cady Co., Inc., Hartford, Conn., will install a furnace having an output of 14 tons daily for the manufacture of castings for valves and fittings. The Dayton Steel Foundry Co., Dayton, O., will install a second electric furnace to supplement the one now in operation. This will have a daily ontput of 30 tons of steel. This company specializes in steel wheels and automobile castings. The Stearns-Roger Mfg. Co., Denver, Colo., will install a Snyder electric furnace for the manufacture of steel castings. This furnace will have a daily output of seven tons and will be the first furnace of this type installed in this section of the country. The Chile Exploration Co., New York City, has purchased its third Snyder electric furnace, which will be used in the development of special alloys at Chuquicamata, Chile.

The Properties of Semi-Steel Castings

(Concluded from page 58)

is not so brittle. In carbonizing ordinary steel there is an addition of carbon to the outside surface of the steel. In this case the action has been the reverse as the long heating in the carbonizing material has reduced the total carbon, leaving practically a 0.90 per cent carbon steel edge. The graphitic carbon has been absorbed by the iron in the center of the punch which accounts for the large amount of cementite. The magnification is 25 diameters.

Fig. 30 is taken from a sample of a punch that was brittle. The brittleness in this case is due to the graphitic carbon particles, which are represented as the black lines. The background is hardened steel. The magnification is 400 diameters. This shows how the carbonizing exhibited in Fig. 29 affected the strength of the material. Fig. 31 is a micrograph of a semi-steel test bar. You will notice that the graphitic carbon has more or less taken the form of globules. The rest of the material is steel in nearly a completely austenitic condition; austenite being a hard substance, the material is consequently very hard. There is also some martensite represented by the medium colored portion; this is also a hard material. Slow cooling of this material will make it considerably softer and tougher.

It is only fair that we hear from a chemist and metallurgist who has handled thousands of semi-steel samples. This letter, addressed to the writer by C. J. Atkinson, Milwaukee, and dated July 19, 1916, is as follows:

"The series of micrographs and chemical analyses I have made for you of semi-steel and ordinary gray cast iron are exceedingly interesting in several ways. The difference in this semi-steel from gray cast iron is particularly noticeable in the formation of the graphitic carbon. In cast iron where there is a large mass of metal, the graphitic carbon is always found in large flakes, whereas with the semi-steel the graphitic carbon is in exceedingly small flakes and in small granules.

"This is very important as it is the graphitic carbon content in cast iron that makes it so brittle, by breaking up the structure of the metal. This is the reason why the samples submitted are so strong. Another feature is the high sulphur content of these steels. If this had been cast iron with this high sulphur, they would have been exceedingly hard because sulphur has a tendency to promote chill.

"Another factor which helped the material, in none of the samples have I found any blow holes or microscopic cavities. The material appears to be exceedingly close.

"In nearly all the samples examined, the combined carbon content was high. This, of course, is due largely to the high sulphur; in all cases with the exception of two which showed chill, the material is easy to machine. The combined carbon is the carbon combined with iron forming steel. and if the combined carbon content were 0.835 per cent, the whole of the iron would be in the form of steel.

"Pearlite, which appears under the microscope or in the photograph as a dark substance, laminated or speckled under high magnification is really iron saturated with carbon, forming steel. Graphitic carbon appears under the microscope as black specks or lines. In most of the photographs, though, these cannot be easily detected as they are more or less obscured by the pearlite.

"The white or light colored areas which contain some slight specks or markings, are ferrite which can be described as iron containing a certain amount of impurities. In one or two of the samples there is another white substance which is absolutely structureless. This is cementite, which is a very hard, brittle substance. It is composed of iron containing a large amount of combined carbon. It is only found in those castings that have been chilled.

"Another feature that is extraordinary is the uniformity of this series. Although the castings were of exceedingly varying weights, some having very thick sections and others being exceedingly thin, the metal microscopically was exceedingly uniform, much more so than you would expect to find in gray iron as we know that where the section of a casting is light, there is a tendency for the iron to be exceedingly hard and brittle unless the chemical composition is modified to suit the weight of the casting."

Chicago Foundrymen's Club Elects Officers

At the monthly meeting of the Chicago Foundrymen's Club, held Jan. 13, officers for the ensuing year were elected as follows: Oliver Smith, president; R. T. Martin, vice president, and C. E. Hoyt, secretary and treasurer. Directors for two years were elected as follows: R. W. Kinder, A. W. Lemme, Alex Thompson and George H. Manlove, Chicago representative of *The Foundry*.

Different Kinds of Iron

By W. J. Keep

Question:—I am considerable of a novice insofar as information regarding cast iron is concerned. All cast iron is the same to me although I understand that various grades have inherent qualities which impart exceptional strength, close grain, unusual softness, chilling qualities, etc. I would like to know the differences between some of the various grades of cast iron.

Answer:—Your question is not at all out of order. Iron ore, from which pig iron is made, is oxide of iron which contains oxides of sulphur, phosphorus, manganese and silicon. The fuel used to eliminate the oxygen to produce metallic iron as well as the metalloids just mentioned, adds to the percentage of sulphur. By adding lime, by varying the proportions of the various so-called impurities in the iron and by mixing different ores, the quality of the iron is varied to meet different requirements.

Evidently, to you, all pig iron seems the same, yet differences exist in the manner in which the grains knit together imparting variations in strength.

Also, the size and hardness of the grains vary which cause differences in strength. These mechanical properties, to a considerable extent, are produced by the chemical composition of the iron and the proportions of carbon, silicon, sulphur, phosphorus and manganese. Nature has provided a convenient means for measuring the influence of these variations in composition. While cooling from a molten to a solid state and from that point until the granular structure has settled to its final form, swelling and contraction occur which have a definite influence upon the final size of the casting. In addition to these changes, the metal contracts for each degree of heat that leaves it, so that the final casting always is smaller than the pattern from which the mold is made. However, the final sizes of castings from different iron mixtures vary considerably. The common term applied to this is shrinkage per foot. In 1894 the writer discovered that this shrinkage varies with the varying proportions of the different elements and with the rate of cooling, and he constructed several kinds of apparatus to measure the variations in shrinkage.

Strength of Cast Iron

Strength depends largely on the size of the grains and upon the way each interlocks with those next to it, as well as upon the hardness of the grains or perhaps more correctly, upon their toughness. It has not been learned why these last properties vary, but by experimenting with various irons that look alike and which analyze the same, we can ascertain which brand of pig iron gives us the strongest mixture. Strength depends largely upon the hardness and toughness of the grains. This is produced by increasing the percentage of the carbon in the combined state. By varying the state of the carbon, the amount of the combined can be increased by reducing the percentage of silicon or by increasing the sulphur content. However, by carrying this too far the grains become brittle and the iron will be weakened. If the percentage of silicon is increased by adding the proper amount of 50 per cent ferrosilicon, the grain size will not be increased and the iron will be soft so that it can be machined readily. This also decreases brittleness and often increases the strength. Strength therefore, depends upon the mechanical structure as much as upon the chemical properties of the metal.

The size of the grains depends largely upon the time given for the action of the influence referred to, in other words, upon the rate of cooling. A large casting cools slower than a small one. The surface of a large casting cools first and, therefore, the grains in a large casting and the grains in the center of any casting will be coarser than those of a small casting and the grains of the metal nearer the surface. The strength of the smaller casting per square inch of structure will be much greater than the larger casting.

For ordinary machinery castings or for light hardware, a non-chilling iron is required. A malleable iron casting is white before it is annealed and yet it should have no chilling qualities. The grinders for corn mills and also plow points should be chilled on their wearing surfaces while the backing metal should be tough and soft. Car wheels must have treads hard and tough, effected by chilling, while the web and hub are soft. Some kinds of iron will chill when the molten metal is run against solid metal. If the chiller is cold the iron solidifies the instant it comes in contact with the chiller and shrinks away from it while at the same time the chill is heated and expands. This causes a shallow chill and if the chill could be heated so the contact would be longer, the chill would be deeper.

Of two irons which will be white when run against the chiller, one will take a true chill and be car wheel iron; the other one, while white, will not take the chill and, therefore, is suitable for malleable castings. Much trouble could be saved if this distinction were observed. It is conceded that any iron can be made white by reducing the silicon and gray, by increasing it, but this will not account for the peculiarity of chilling. An increase of sulphur will increase the tendency to chill. Many charcoal irons are in the chilling class, while others are not, and these chilling irons are exceptionally pure. This has resulted in the addition of steel scrap to non-chilling pig irons which reduces the proportion of all of the elements in the iron owing to the smaller percentages in which they exist in the steel.

Effect of Sulphur

The sulphur in the fuel used for remelting increases the sulphur in the iron and a fairly satisfactory chilling iron is thus produced, but this is not nearly as desirable as charcoal iron with a natural tendency to chill. Phosphorus and manganese, if less than 1 per cent in the castings, exert very little influence. In ordinary foundry practice, the character of a non-chilling iron can be varied by varying the silicon, and the amount of change can be ascertained by measuring the shrinkage, while the actual amount of silicon in the casting can be determined by a chemist.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Macungie Brass Mfg. Co., Macungie, Pa., contemplates extending its foundry.

The Regent Stove Co., Wyandotte, Mich., plans to erect a large foundry addition.

The Green Engineering Co., East Chicago, Ind., contemplates the erection of a foundry.

Beatty Bros., London, Ont., will build a foundry at a cost of $30,000.

The Western Foundry Co., Wingham, Ont., will erect a $15,000 addition to its plant.

The Semi-Steel Foundry Co. will erect a $25,000 casting plant at Barberton, O.

The Detroit Valve & Fittings Co., Detroit, contemplates building a $40,000 addition to its foundry at Wyandotte, Mich.

A foundry and nickel-plating shop will be erected by the Wilson Stove Co., Metropolis, Ill., at a cost of $45,000.

Plans are being prepared for an addition to the steel foundry of the Whiting Foundry Equipment Co., Harvey, Ill.

The Strong Steel Foundry Co., Buffalo, has awarded a contract for the erection of a 25 x 80-foot foundry addition.

The Holt Mfg. Co., Peoria, Ill., is planning to erect a foundry, 200 x 300 feet, at a cost of $100,000.

The Turner, Vaughn & Taylor Co., Cuyahoga Falls, O., is building a large foundry to replace the one recently torn down.

A contract has been let by the Waterbury Foundry Co., Waterbury, Conn., for the erection of foundry addition, 30 x 60 feet.

A two-story addition will be built by the Chicago Malleable Castings Co., 1219 West 120th street, Chicago, at a cost of $15,000.

The Baldwin Locomotive Works will build a 100 x 300-foot addition to its foundry at Eddystone, Pa.

The Crucible Steel Co., East Liverpool, O., is building a foundry at Midland, Pa., to cost $75,000.

The Western Foundry & Sash Weight Co., St. Louis, will build additions to its plant at a cost of $12,000.

Two additions, 61 x 185 feet and 44 x 58 feet, will be made to its foundry by the American Malleable Casting Co., Marion, O.

The plant of the Auburn Foundry Co., Auburn, Ind., recently damaged by fire, will be rebuilt.

The Nevada Engineering & Supply Co., Reno, Nev., will erect additions to its foundry and machine shop.

A contract has been awarded by the General Electric Co., Schenectady, N. Y., for the erection of a large foundry extension.

Plans have been prepared for rebuilding the foundry of the Central Foundry Co., Hamilton, O., recently damaged by fire.

The American Foundry & Mfg. Co., St. Louis, will rebuild its plant recently damaged by fire.

A contract has been awarded for improvements to the plant of the Bayonne Casting Co., Bayonne, N. J.

The La Plant Co., Marshalltown, Ia., will erect a 2-story, 60 x 90-foot addition to its foundry at a cost of $6,000.

The Davis Mfg. Co., Fifty-seventh and Mitchell streets, West Allis, Wis., contemplate building an addition to its foundry.

A contract has been awarded by the Hood Rubber Co., Watertown, Mass., for the erection of a foundry and pattern shop, 80 x 160 feet.

The Vermillion Malleable Iron Co., Hoopeston, Ill., will build additions to its foundry and pattern shop, 49 x 56 feet and 40 x 56 feet, respectively.

The Lakey Foundry Co., Muskegon, Mich., will build a foundry, 200 x 310 feet, which will treble its present capacity of approximately 40,000 tons daily.

A fonndry costing $30,000 will be erected at Oakley avenue and Thirty-fifth place, Chicago, by the Reder Foundry Co., 2125 Canalport avenue, that city.

Work will be started in the spring on a 150 x 250-foot addition to the plant of the Bass Foundry & Machine Co., Fort Wayne, Ind.

The Hartford Iron Works, a partnership recently formed by I. L. Bonniwell and Louis Rosche, is remodeling a building at Hartford, Wis., to be used as a foundry.

Reuther Bros., Harrison, N. J., gray iron founders, will build two 2-story buildings, 70 x 200 and 25 x 175 feet, respectively, and several small structures.

A contract has been awarded by the J. E. Lonergan Co., 211 Race street, Philadelphia, for the erection of a brass foundry at Second and Florist streets.

A steel plant and rolling mill will be erected at Cobourg, Ont., by the Federal Steel & Foundry Co. J. H. Cole, Corbett Foundry & Machine Co., Owen Sound, Ont., is manager.

A one and two-story, 150 x 500-foot machine and electrical shop, to cost approximately $500,000, and a one and two-story, 225 x 500-foot foundry, to cost $500,000, will be built at the Norfolk, Va., navy yard.

The Producers Supply Co., Franklin, Pa., manufacturer of steel tanks, forgings, and valveless gas engines, will erect a gray iron foundry of reinforced concrete construction, 75 x 200 feet.

A contract has been let by the Holland Furnace Co., Holland, Mich., for the erection of a plant at Cedar Rapids, Ia. The building will be 160 x 400 feet, half of which will be devoted to foundry use and the remainder for fitting rooms, sheet metal depart-

The Westinghouse Electric & Mfg. Co. will erect a large plant at Essington, Pa., which will include two machine shops, a foundry, a pattern storage and an assembling shop. The plant will be devoted to the manufacture of ship and ship building equipment, turbines, etc. The Westinghouse, Church, Kerr Co., 37 Wall street, New York, is the engineer.

A company has been organized at Oakland, Cal., by Sydney A. Splain, 3330 Elm street, that city, to engage in the manufacture of gray iron castings. A plant will be built at an expenditure of $30,000. The erection of a shop already has been commenced. Sydney A. Splain is president of the company and will be foreman of the foundry, William Cobb is vice president and general manager, Edward Cute secretary and John Weaver is treasurer and foreman of the core room.

General Industrial Notes

The Leetsdale Foundry & Mfg. Co., Leetsdale, Pa., has been organized with a capital of $30,000.

The Nelson Co., Menominee Falls, Wis., which operates a foundry and machine shop, has changed its name to the Menominee Falls Mfg. Co.

The Modern Brass Foundry Co., St. Louis, has been incorporated with a capital of $3,000 by Carl G. Strotz, John P. Hill and Louis C. Strotz.

The East Chicago Foundry Co., East Chicago, Ind., has established a plant at 148th and Railroad avenues for the manufacture of gray iron castings.

The Hall Foundry & Mfg. Co., Muskogee, Okla., has been incorporated with a capital of $50,000 by J. T. Davis, C. E. Hall and W. L. McClellan.

The Harris Foundry Co., Akron, O., has been incorporated with a capital stock of $10,000 by C. L. Steffey, L. N. and S. J. Harris, D. M. Skelton and F. W. Hachtel.

The Belleville Malleable Iron Co., Belleville, Ill., has been incorporated with a capital of $2,500 by Paul Joguel, C. Herzog and George C. Logan.

The Capital Machinists & Founders Co., Ottawa, Ont., has been incorporated with $50,000 capital by Michael J. Skelly, Walker L. Goode and Ephriam P. McGill, of Ottawa.

The Clefton Co., Owatonna, Minn., has been incorporated to engage in the manufacture of plumbing supplies and brass goods with a capital of $25,000.

The Alliance Brass Foundry Co., Detroit, has been incorporated with $50,000 capital, by Albert Manche, Highland Park, Mich., and Edmund M. Sloman and D. W. Berry, Detroit.

The Central Foundry Co., Webb City, Mo., has been purchased by the Carterville Sheet Metal Works Co., Carterville, Mo., at a price of $108,000. No changes in the management of the purchased plant are contemplated.

The Chicago Hardware Foundry Co., North Chicago, Ill., has purchased the plant of the North Chicago Foundry Co., of the same place. This shop is devoted to the production of light castings and hardware specialties.

The Dominion Boiler & Foundry, Ltd., Montreal East, Que., Can., has been incorporated to engage in the manufacture of boilers and furnaces with $200,000 capital. The incorporators are Charles W. Webb, J. H. Charbonneau and Victor Pelletier.

The Variety Iron Works, Seattle, Wash., established in 1889 and one of the first foundries in that territory, has been purchased by the Skinner & Eddy Corporation, recently organized to engage in ship building.

The Dodge Mfg. Co. has been incorporated with a capital of $500,000 to engage in business as founders and engineers at Toronto, Ont., Can. Charles F. Wheaton, William G. Thurston and James Shand are the incorporators.

The Metal Foundries of Canada, Ltd., has been incorporated at Montreal, Que., with $50,000 capital. The incorporators are John M. Duff, 157 Bay street; James G. Hamilton, Marjorie L. Chamberlain and others, all of Toronto.

The G. R. Wilmoth Co., Kenton, O., has been incorporated with a capital of $12,000 to engage in the operation of a gray iron foundry. G. R. and A. E. Wilmoth, J. C. Ruech Jr. and W. H. Grimer Jr., are the incorporators.

The Lima Metals Foundry Co., Lima, O., has been incorporated with a capital of $15,000. The officers of the new company are A. H. Workman, president; J. F. Racine, vice president and W. J. Noonan, secretary and treasurer.

The Pembroke Machinery Co., Pembroke, Ont., has been incorporated to conduct a general foundry and machine business with $100,000 capital. The incorporators are Edward A. Dunlop, James F. Muiro, of Pembroke, and George J. Bryson, Ottawa.

The plant of the Grey Iron Foundry Co., Beaver Dam, Wis., which has been idle for several years, will be reopened by the Beaver Dam Casting Co., recently incorporated with a capital of $10,000. Cast iron and semi-steel castings for automobiles will be produced.

The B. B. Noyes Co., Springfield, Mass., has been incorporated to engage in the operation of a foundry and machine shop. The company is capitalized at $12,000 by Winthrop T. Noyes, Gertrude S. Cumming and Margaret T. Noyes.

The International Mfg. Co., Ottawa, Ont., Can., has been incorporated to engage in the manufacture of firearms and shells and to conduct a foundry and machine shop. The company is capitalized at $100,000 by John A. Harris, Rufus A. Patterson, Alfred O. Hoyt and others, of New York.

The Ohio Pattern Works & Foundry Co., Cincinnati, has been incorporated to take over the business of the Ohio Pattern Works, located at 2730 Spring Grove avenue, that city. The new company is capitalized at $200,000 by J. E., A. S. and E. B. Hausfeld and V. E. and G. L. Trisese.

The Dominion Boiler & Foundry Co., Montreal, Que., Can., has been incorporated to engage in the manufacture of furnaces, boilers, radiators, machinery, etc. The company is capitalized at $200,000 by Charles W. Webb, Joseph H. Charbonneau, Victor Pelletier and others.

The American Trap Co. has been incorporated at Detroit wtih $10,000 capital to engage in the manufacture of plumbing and heating supplies and conduct a general foundry business. J. L. Wells, B. C. McClellan and R. J. Fenton are the incorporators. The company will carry on its business at Toledo, Ohio.

The Lebanon Gear & Machine Co., Lebanon, Pa., has been incorporated with $25,000 capital to engage in the operation of a foundry and machine shop. The incorporators are H. T. Gerdes, A. F. Sinclair, Godfrey Engle Jr., 30 Church street, New York; R. E. Fowler, Hanover, Pa., and R. N. Gerdes, 123 Liberty street, New York.

The Flint Foundry Co., Flint, Mich., has been organized by W. H. Goldstine, superintendent of the brass and aluminum foundry of the Buick Motor Co. The officers follow: W. H. Goldstine, president; William Gregory, secretary and treasurer and E. B. Gilmore, factory manager. The foundry will specialize in automobile castings.

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Making Gray Iron Art Work

How Ornamental Castings Requiring Absolute Conformity to Pattern and Surfaces Suitable for Plating or Polishing Are Made

By E C Kreutzberg

ART collections frequently include among their most interesting and valuable specimens, exceedingly intricate grille work, lace and other patterns cast in gray iron. To the lover of art they take rank as the super-product of the Michael Angelos, Whistlers and Rodins of the foundry, and the casual observer who is at all familiar with foundry practice wonders how it is possible to cast such pieces in gray iron which generally is regarded as a metal unsuitable for work in which beauty and refinement of execution predominate. Gray iron castings of this character are liable to be regarded as the product of artistic genius rather than that of a thorough understanding of all of the many elements which enter into molding and melting and skill of a high order in utilizing this knowledge. As a matter of fact, the production of such castings requires no genius unless it is considered that genius is only infinite capacity for attention to detail, and they can be produced in any foundry where knowledge and skill are of a sufficiently high order. The truth of this statement is proved by the fact that castings which require utmost perfection in detail, which must conform without blemish to intricate patterns, which must be perfectly run despite the contiguity of thin and heavy sections, and which embody all the features of art castings, are being produced in gray iron for ordinary commercial purposes on a constantly increasing scale.

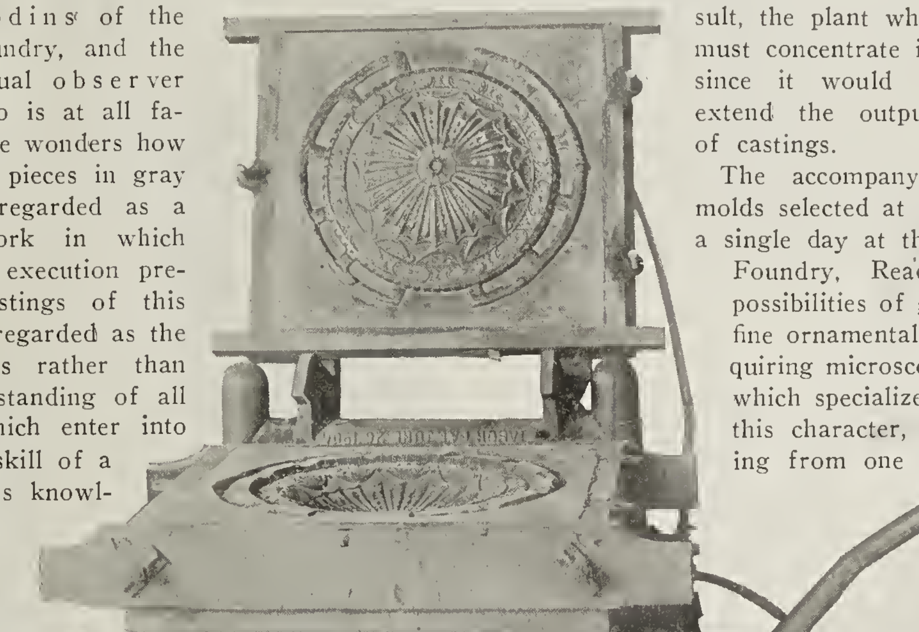
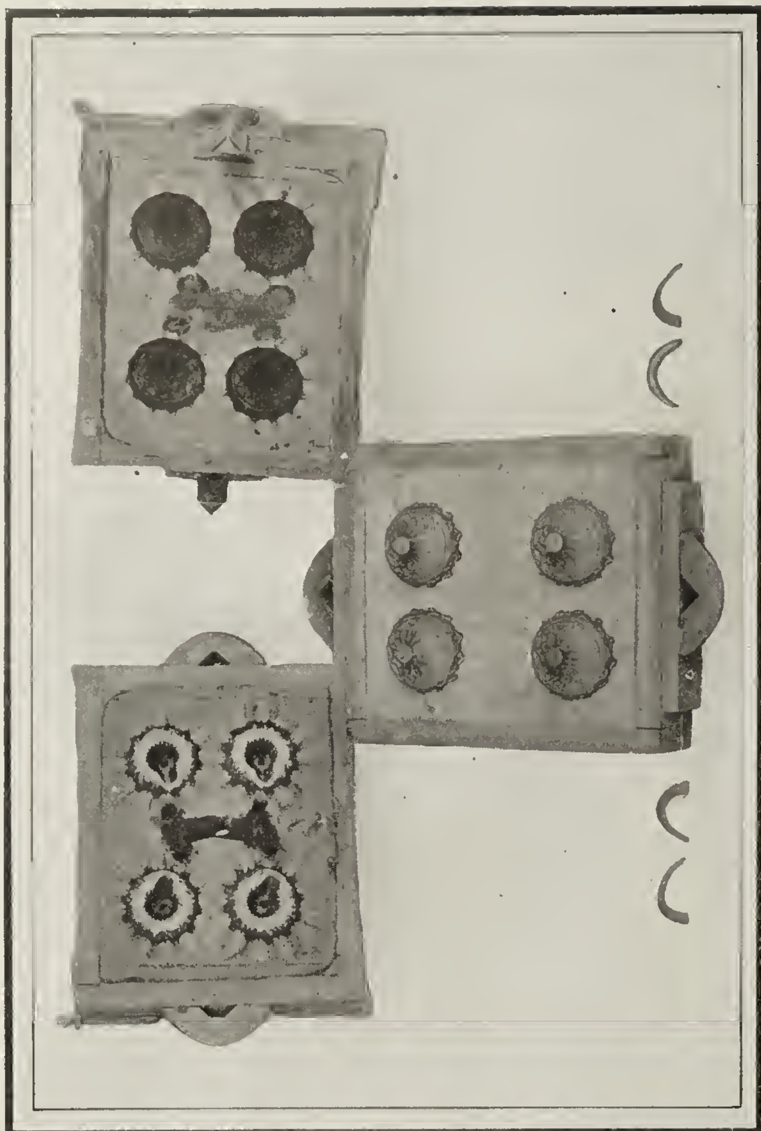


FIG. 1—MOLDING DRAG SECTION OF ORNAMENTAL DOME MOLD ON ROLL-OVER MACHINE

The painstaking attention to all details and the carefully selected raw materials which are necessary to produce such castings naturally contribute toward a higher manufacturing cost than is usual in foundries. As a result, the plant which engages in fine work must concentrate its efforts along this line, since it would not prove profitable to extend the output to the ordinary run of castings.

The accompanying illustration showing molds selected at random from the heat of a single day at the Edwin A. Moore Iron Foundry, Reading, Pa., indicate the possibilities of gray iron when applied to fine ornamental castings, and castings requiring microscopic accuracy. This plant, which specializes successfully in work of this character, produces castings weighing from one ounce up to 500 pounds, and its output is limited entirely to pieces which require absolute conformity to pattern and a perfect surface suitable for plating or polishing. To such fine limits does the work gage, that the company guarantees all castings, even where thin sections, 2 x 18 inches and scant ⅛-inch thick, are involved, to show a deviation from perfection of less than 0.007-inch. It further guarantees that the castings it produces may be machined at a cost of 60



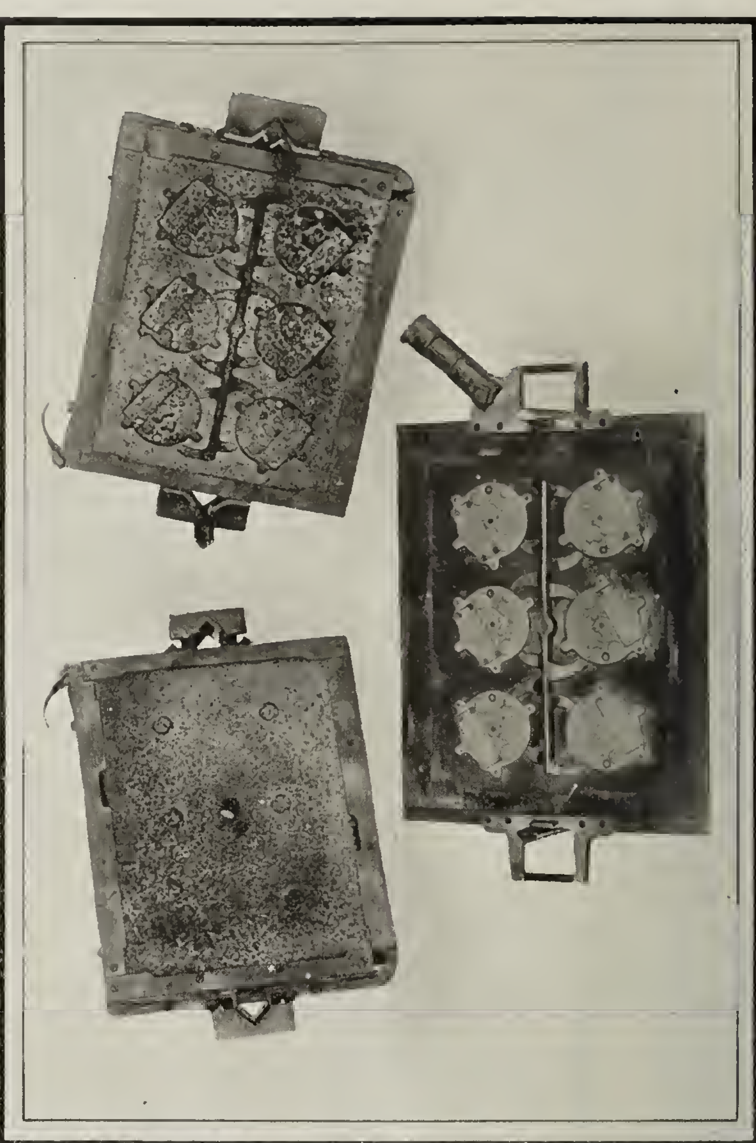
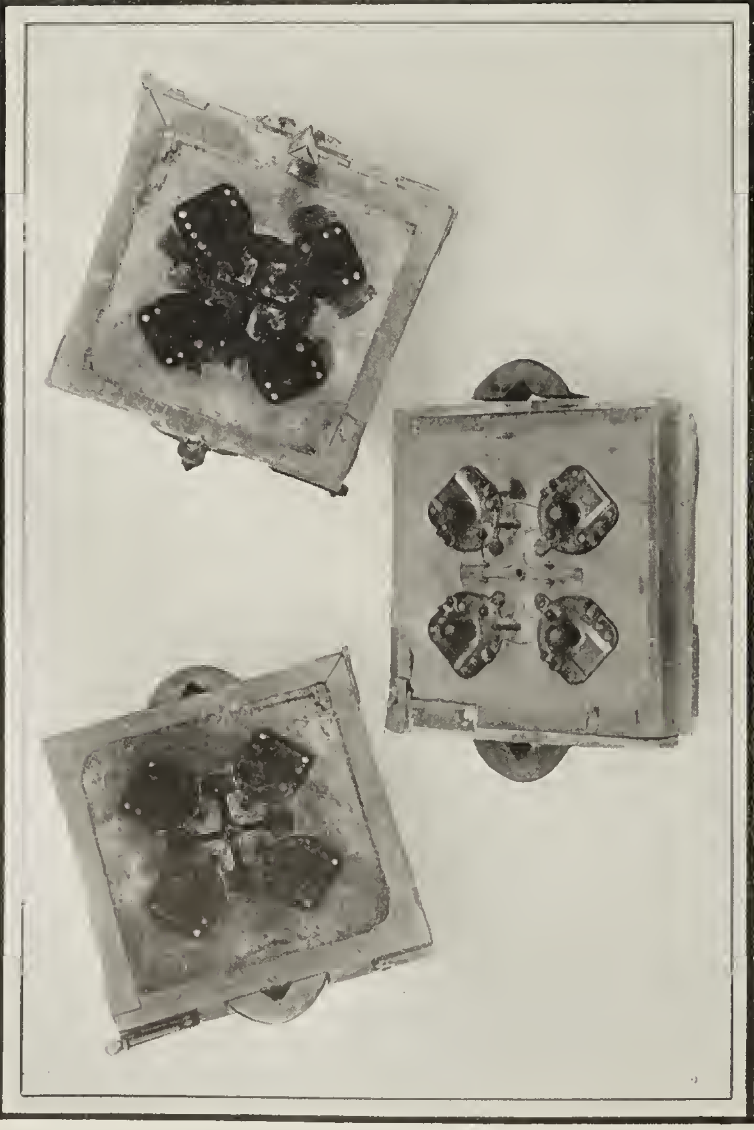


FIG. 3—MOLD FOR LIGHTING FIXTURE IN WHICH ORNAMENTAL DETAIL IS SO FINE AS TO PRECLUDE THE USE OF ORDINARY GATES

FIG. 5—MOLDING AN AUTOMOBILE IGNITION SYSTEM CASTING IN WHICH THIN SECTIONS AND SCREW HOLES AT CORNERS, PRESENT UNUSUAL DIFFICULTIES



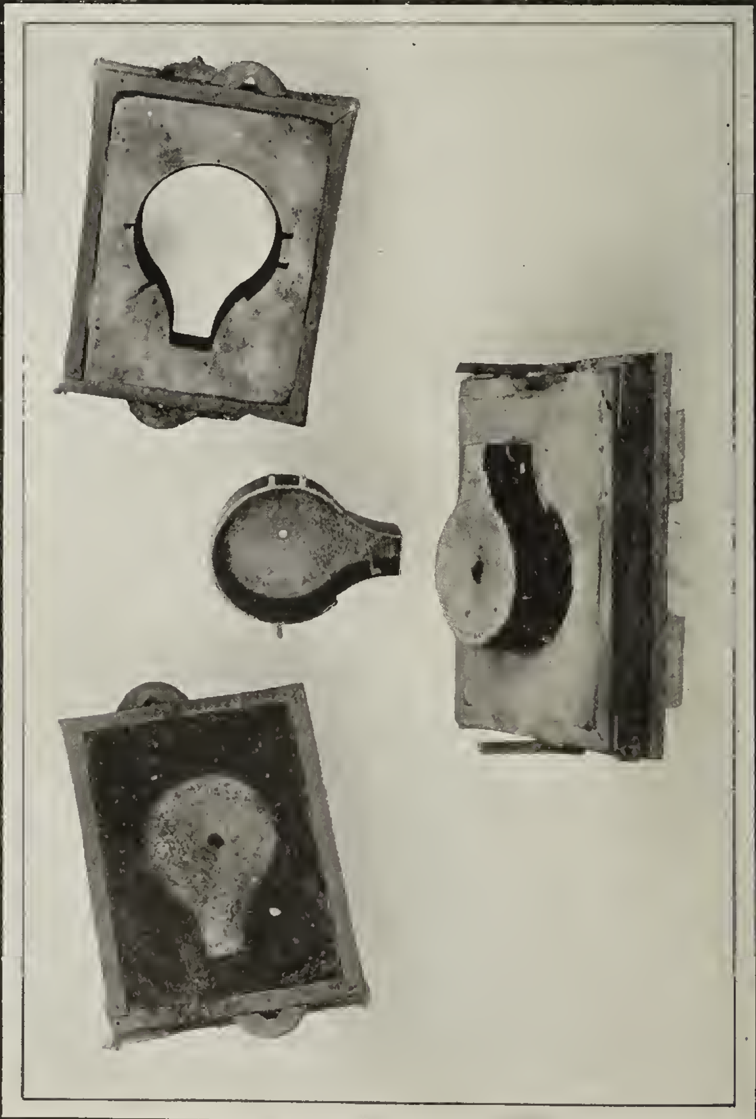


FIG. 2—MOLD AND PATTERNS FOR AN AUTOMOBILE IGNITION SYSTEM CASTING IN WHICH HEAVY LUGS ARE POURED THROUGH EXCEEDINGLY THIN SECTIONS

FIG. 4—MOLD FOR PYROMETER CASE CASTING IN WHICH THIN WALLS AND LUGS CAUSE TROUBLE

per cent as compared with the machining cost of similar castings made elsewhere.

The output of the Moore foundry includes dental castings, small complex parts of adding machines, parts for typewriters, moving picture, textile and other machines, all kinds of art work such as door knockers and lighting fixtures, etc. With the exception of two molding machines, hand-ramming is practised exclusively, both on the floor and on the bench. This is due to the necessity, particularly exigent in this shop, for ramming some portions of the molds harder than others. In addition to ramming, the condition of the sand, the methods of venting the molds, the location of the gates and the correct use of facing all are given careful attention, since it has been found by careful study that most of the discount results from poorly-designed and constructed molds. The mixture and melting of the iron also receive careful consideration. The company recently experimented with an alloy obtained by the addition of small quantities of Boron copper to gray iron, and the resulting mixture has been shown to possess high resistance to corrosion. This alloy is called "caboron metal".

Ornamental Castings

Figs 1, 6 and 10 show the molds for ornamental castings. The one illustrated in Fig. 6 is for an artistic doorholder. The rooster design must be brought out sharply since the casting later receives a decorative treatment which brings out all defects. The output is 50 molds per day and the discount averages 8 to 10 per cent, due largely to washing and cutting of the sand, which destroys the detail of the surface. The weight of these castings, which are put up on the bench in an ordinary snap flask, is seven pounds each. Fig. 1 shows a roll-over machine on which the drag of an ornamental dome is molded and Fig. 10 is a view of another machine of the same type for making the copes. The principal requirement of this casting is that the ornamental detail, which is intricate and exceedingly regular and sharp, be brought out perfectly. The output, per day, is 15 molds and the discount is about 20 per cent, due mainly to imperfections arising from the washing and cutting of the sand. The metal in this casting is 3/16-inch thick.

Automobile Ignition Casting

Fig. 2 illustrates the mold and patterns for an automobile ignition system casting. These pieces are made four in a mold in an ordinary snap flask and the mold is poured through a circular gate having two branches to each casting. The chief difficulty encountered in making these castings arises from the necessity of maintaining several lugs.

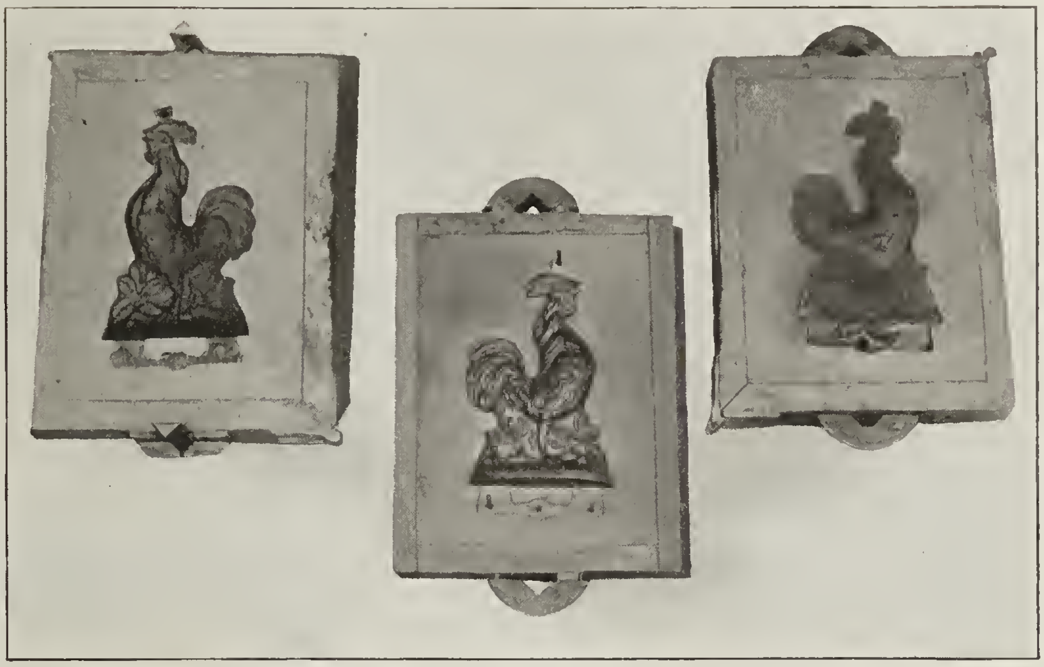


FIG. 6—ROOSTER DOOR HOLDER MOLD AND PATTERN

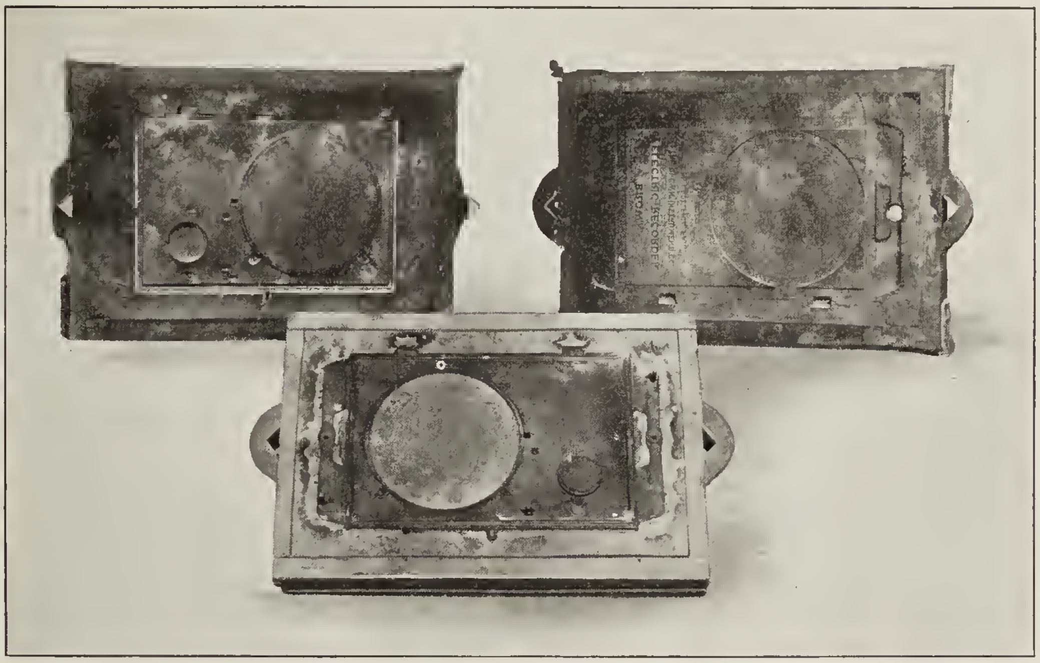


FIG. 7—PYROMETER CASE DOOR MOLD IN WHICH LETTERING AND PEBBLED MATTE MUST BE BROUGHT OUT SHARPLY, AND CASTING MUST BE ABSOLUTELY STRAIGHT

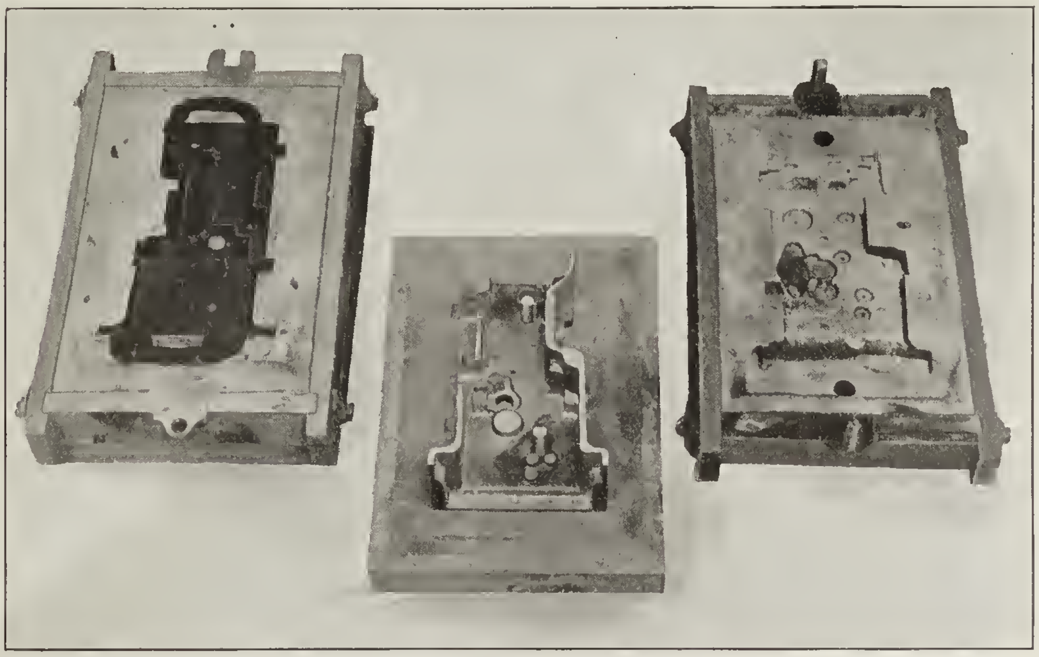


FIG. 8—MOLD FOR MOVING PICTURE MACHINE CASTING IN WHICH DIFFICULTY IS ENCOUNTERED DUE TO CONTIGUOUS THIN SECTIONS AND HEAVY LUGS AND TO THIN SAND WALLS

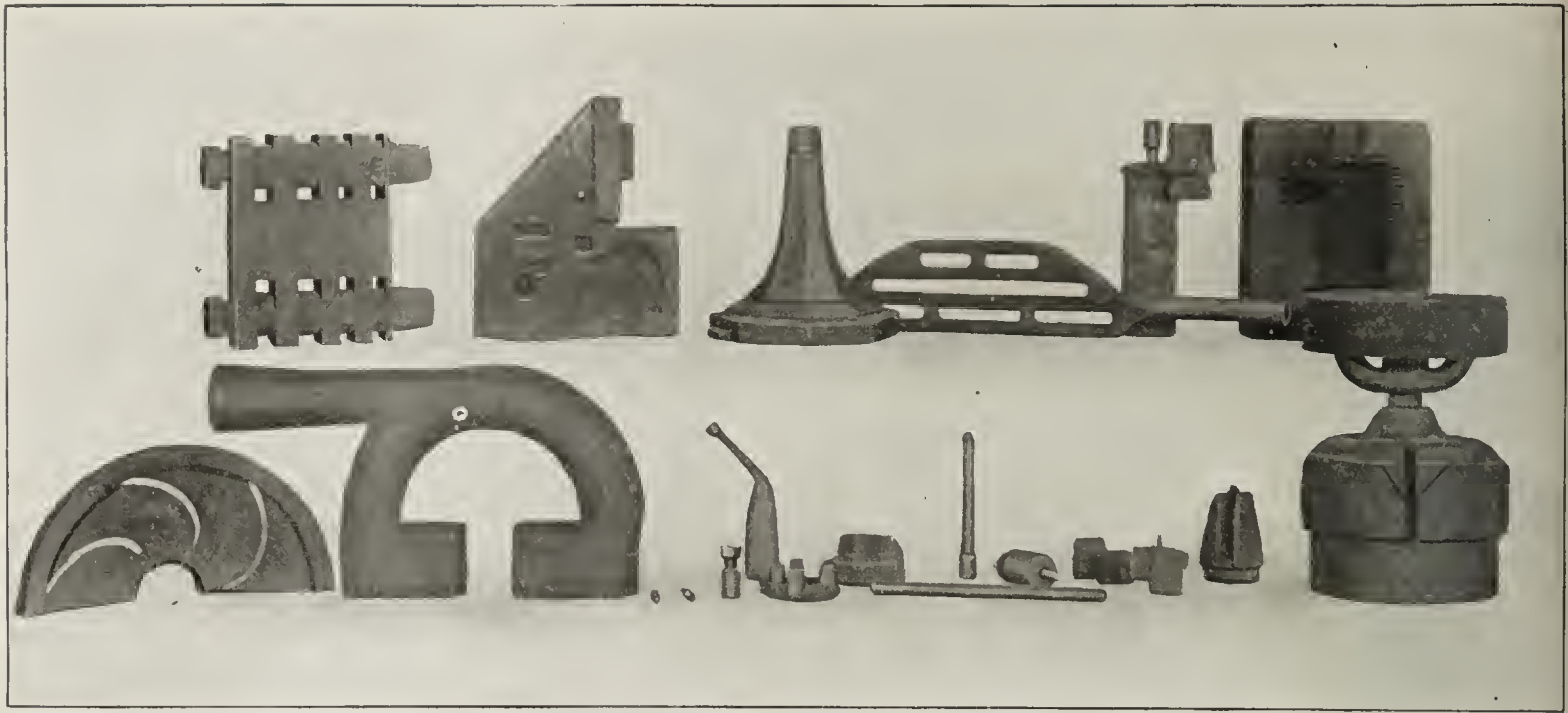


FIG. 9—TYPICAL CORES PRODUCED AT THE MOORE FOUNDRY

The heaviest lug is 1¼ inches in diameter and 1½ inches long; it is located 1¾ inches from the gate and the iron must flow into it through a section, 1/32-inch thick. A requirement of this casting is that the drill lugs, which are 3/32-inch thick, must withstand a drilling speed of 1,600 revolutions per minute; thus the iron must be free from chill. Each casting weighs ½-pound. The output per day of seven hours, is 16 molds, or 240 castings, and approximately 80 per cent of these pass inspection and are approved for shipment. Most of the discount results from short runs, due to insufficient or improper venting, or faulty condition of the sand.

Fig. 3 shows the mold for a gaslighting fixture, together with the patterns and the match-plate. Due to the sharp outlines of the ornamental details of this casting, it is impossible to use a gate of the ordinary type and therefore the mold is poured through horn gates. The output is 40 molds, or 160 castings per day and the discount is 33 1/3 per cent, due chiefly to the washing and cutting of the sand. Owing to the fact that these castings later are polished, an exceptionally smooth finish is required, but so perfectly is the pattern reproduced, that it has been found unnecessary to treat them in any other way than with the sand-blast. These castings weigh 1 pound, 5 ounces each.

Pyrometer Case Casting

Another difficult mold, shown in Fig. 4, is that for a pyrometer case. The features of this case are the depth of the draw, the thinness of the walls, the thickness of the lugs in the case, and the thinness and lengths of the lugs and the latch on the rim of the casting. The case has a depth of 3¾ inches and weighs 8½ pounds, the thickness of the walls being 3/32-inch. In making this mold, careful ramming is required, some portions being rammed hard while in other knuckling suffices. This mold is put up in three parts, a drag, a cheek and a covering cope, and it is provided with two gates. The day's heat is 18 molds, with an average of 16 good castings. Most of the discount is due to swelling of the sides and cold shot in the back of the casting.

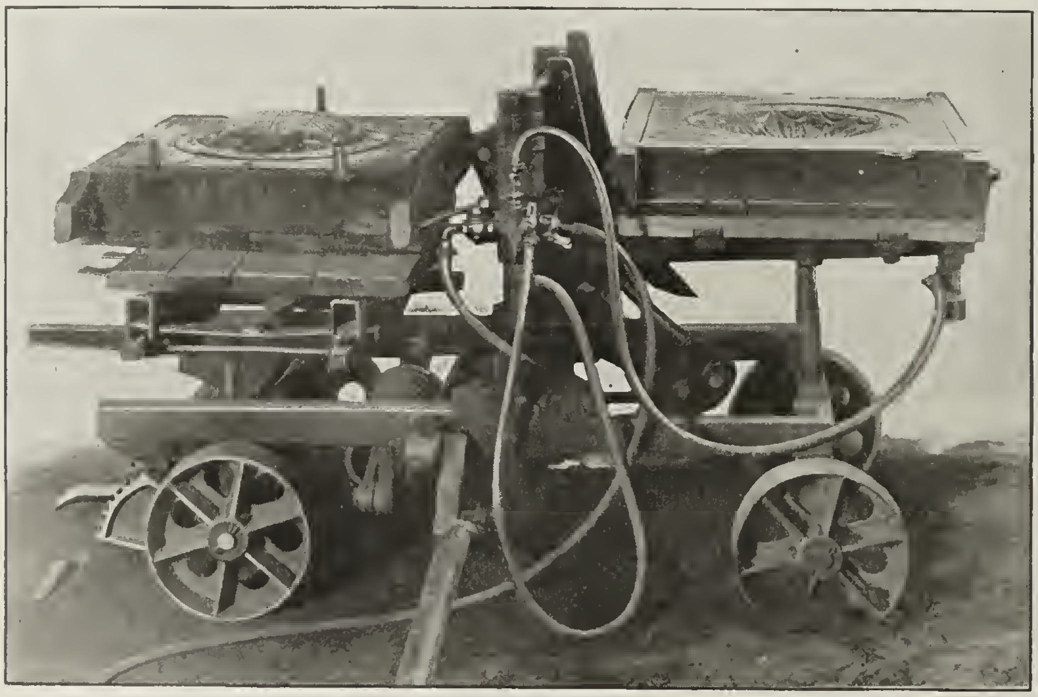


FIG. 10—MOLDING THE COPE FOR ORNAMENTAL DOME MOLD ON ROLL-OVER, DRAW MACHINE

Fig. 5 shows the mold and patterns for another automobile ignition system casting. These pieces are cast six in a mold and are put up in an ordinary snap flask. Each weighs six ounces and averages 1/32-inch in thickness, with the exception of the drill lugs, which are 3/32-inch. Despite the thin wall section, the casting must be kept soft enough so that it may be drilled by a gang drill at high speed. It must be cast absolutely true to pattern, since it is fitted with great accuracy. The discount arises chiefly from defects in the lower corners of the castings, where exceedingly fine loops are required to form screw holes. To prevent the corners from being cut and washed by the metal, it is necessary to sponge them, with the result that considerable gas is generated when the mold is poured. The condition of the sand, therefore, must be correct and the mold must be vented properly that this gas may be removed as soon as it is generated. The output is 60 molds per day, or 360 castings, and the discount averages only about 12 per cent.

Fig. 7 shows the mold for a pyrometer case door, together with the pattern and match-plate. The mold is made in an ordinary snap flask and the casting is 10 x 15½ inches, weighs 4¾ pounds and is 3/32 inch thick, with the exception of

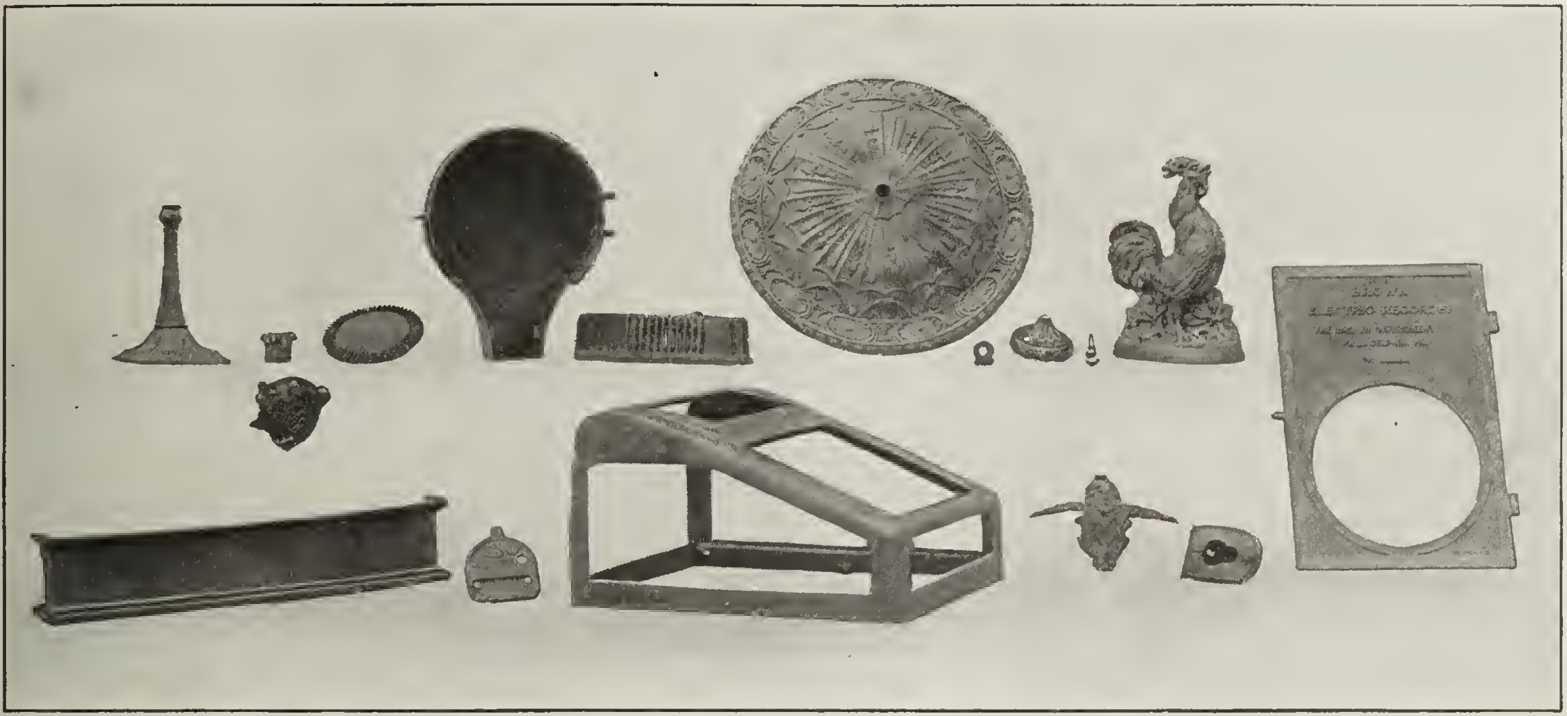


FIG. 11—TYPICAL CASTINGS PRODUCED AT THE EDWIN A. MOORE FOUNDRY, READING, PA.

the border, which is a scant ⅛-inch. The chief requirements are that the casting be true to pattern, straight within a limit of 0.007-inch, and that the sharpness of the lettering and of the pebbled matte be unblemished. Perhaps the most difficult feature is the maintenance of the lugs on the back and the small lock loop on the edge of the casting. To produce a perfect casting, therefore, the mold must be vented with great care since considerable sponging is necessary. The daily output is 25 to 30 molds, resulting, on the average, in 20 perfect castings.

Fig. 8 shows the mold and pattern for a moving picture machine. This mold is made on the bench in an ordinary wood flask. The main features of the casting are the depth and thinness of the sections, and the presence of numerous deep lugs and bosses which are located close to each other, thus causing difficulties due to thin sand walls. The sand is exceedingly liable to wash, hence sponging is necessary, with consequent attention to venting. The castings must be absolutely square and hence care must be taken to guard against defects arising from contraction after pouring, since a good deal of freaky shrinkage is liable to result from the thin sections and the adjacent heavy lugs and bosses. The fine limits required are illustrated by the fact that a shift of any of the lugs as much as 1/16-inch is sufficient to cause the casting to be rejected. The casting weighs 12½ pounds, is 4⅝ inches deep and the walls have a thickness of 11/64-inch. The mold has a riser and is poured through two runners. Undesirable effects of contraction are eliminated by uncovering certain sections of the casting immediately after pouring, leaving the mold, as a whole, to be shaken-out after the casting has cooled. Fig. 9 shows some of the intricate dry sand cores made at this foundry, and include cores for a motorcycle cylinder, ceiling plate, car-lighting fixture, gas-meter slot-casting, auto-ignition system casting, timing system casting, gas-heater burner, a turbine casting, punching machine and core for a valve.

Variety of Work

Fig 11 shows typical castings produced by this foundry. From left to right, the top row of castings includes a portable lamp base and column, cast gear wheels, pyrometer case, thermostat case, electric dome plate, lighting fixtures, and a rooster door-holder; the bottom row, left to right, includes a gas-fixture base, ignition system casting, adding machine frame, lighting fixture ornament, slot casting for a gas meter and a pyrometer case door.

One of the most difficult castings made at this plant is that shown in Fig. 12. This is the frame for an adding machine. This casting weighs 11 pounds, is 10½ x 18 inches, and the top slopes up to a height of 11 inches. The thickness of the metal is a scant ⅛-inch, and the casting is provided with several difficult lugs. The pattern is in two parts and is molded on the bench in a 4-part flask. The output is 12 molds per day, and the discount, which is about 25 per cent, results principally from imperfect venting, since ample provision must be made to carry off the gases generated in pouring. These are present in considerable volume, due to the necessity for thorough sponging of the mold in order to prevent washing.

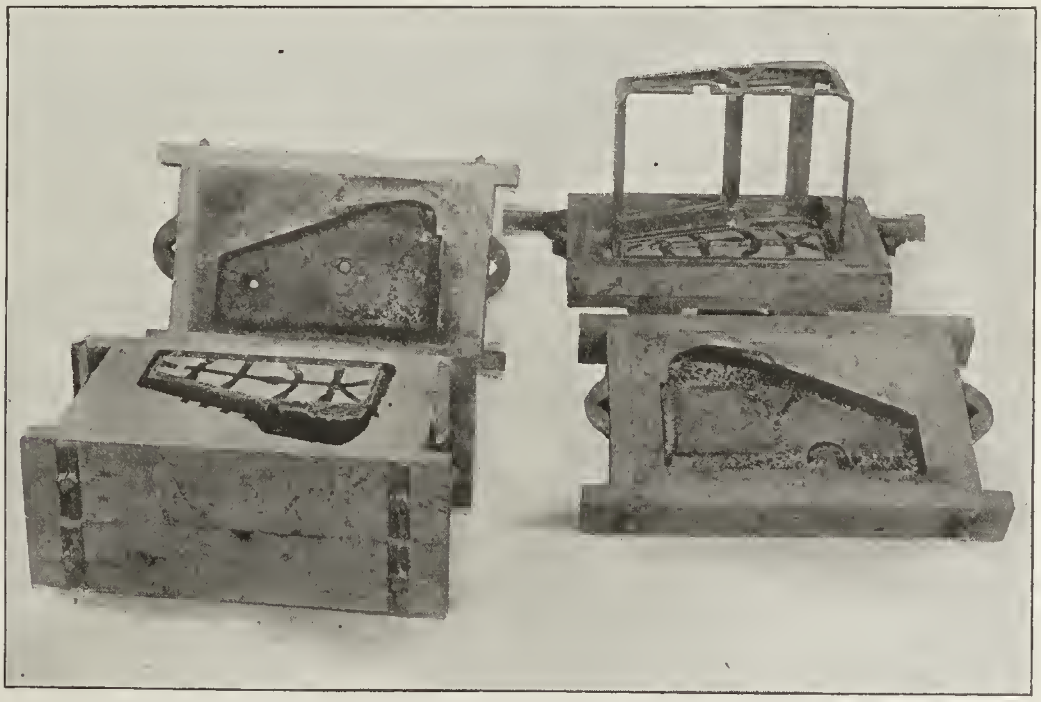


FIG. 12—MOLDING 10½ x 18-INCH ADDING MACHINE FRAME WHICH IS REQUIRED TO VARY FROM PATTERN NO MORE THAN 0.007-INCH

Essential Factors in Foundry Cost Accounting

Intelligent Bidding and Fair Competition Depend Upon a Knowledge of the Cost of Different Casting Operations

By Clinton H Scovell

TOO many foundries are being directed without adequate information coming to the executives as to the cost of the products of different kinds, or for different customers; without sufficient control of expense, or adequate information regarding the cost of unused capacity; and all too frequently, without a production plan which will enable the management to get the most out of the facilities available. This is due to the widespread belief that it is impossible, or impracticable from the standpoint of clerical expense, to have more accurate information.

There are few foundry executives, however, who doubt that they could use precise information of this kind for a more efficient conduct of their operations, if only they could get the records that they need promptly and economically. It is the purpose to point out how these results, admitted to be so highly desirable, can be secured.

Objects of Foundry Accounting

There are three principal objects to be attained by operating an adequate cost and accounting practice in a foundry. First, the management should know the costs on each line of work, and therefore the profits on the product made for the individual customer. The importance of this information will vary in different communities, and in different foundries, according to the number of customers served and the amount of competition, and therefore the accuracy with which quotations must be made (as to customers this applies only to a jobbing foundry).

Second, it is all important that the foundry management should have daily reports and weekly and monthly summaries, of the cost of foundry operations. If the volume of work is fluctuating, it is obviously necessary to watch closely the relation between direct molding and coremaking labor and miscellaneous indirect operating costs. There will naturally be daily reports showing the kind and quantity of material charged, the ratio of metal to fuel, the amount of metal poured out of the daily melt, and the proportion of good and bad castings made. Some of this is only statistical information, and some of it, as for example, the cost of spoiled castings, becomes much more significant when reduced to dollars and cents.

Third, if a foundry is asked to make individual castings which are important as to weight, difficulty of molding, coremaking, cleaning, requirements as to metal, hardness, etc., so that special attention is required at every stage, it will be desirable in such special cases to calculate the cost of individual castings. In a jobbing foundry, handling work for different customers, the character of their patterns will obviously be taken into account in quoting a price, and if that price is uniform for all the requirements of one customer, there is not much to be gained by attempting to get costs on individual castings, except occasionally to see that one or two patterns are not costing too much above the average.

But in a foundry where the work is done almost solely for the machine shop in the same business, the only kind of cost accounting beyond averages that will be of much value is one that will get costs on individual castings, or possibly on groups, like the castings for a line of pumps, for example, in contrast with a line of gasoline engines, if both are made in the same foundry and machine shop.

From this brief survey it is plain that the object to be secured by cost accounting will vary greatly in different foundries, so that what may be an obvious necessity in one plant will be a matter of indifference in another.

An adequate production scheme is one of the essentials for efficient foundry management. It is also the framework for the cost accounting.

There should be a record of all patterns on hand, properly indexed so that they may readily be located. This record should show the date, and from whom received, storage location, pattern number and how many castings are to be made from each pattern. When customers' patterns are returned, the date of the return should be noted on the pattern record before the card is removed to the transfer file.

Upon receipt of an order for castings, at least three copies of the production order can be used effectively. One should remain in the production department, filed by customers or manufacturing classification, and two copies should go forward to the foundry foreman, one for his file and one as an order for patterns. A summary of these orders is kept by the production clerk, classified by customers, and if desirable for production purposes, according to weight of castings or grade of metal. A color scheme may be used in connection with production orders, different colors representing the various weight or grade classifications. A daily analysis of this summary is made by the production clerk and foundry foreman, and the production for succeeding days determined. Postings are made to this record, crediting the good castings made each day and leaving as a balance the number of castings for each pattern yet to be made.

Distributing the Labor Charges

When new patterns are received at the foundry the gross weight of castings to be made from these patterns is calculated. By maintaining the record outlined in the preceding paragraph, the production ahead of the plant can be closely estimated.

Production orders as issued to the foundry should be given serial numbers. These order numbers can be so arranged as to indicate a customer, a class of work, a pattern, or if desirable, all three.

The labor cost will be sharply divided between direct and indirect charges. Even if the direct charges are not further sub-divided, the total payroll should be separated into cupola labor, molding, coremaking, cleaning, pattern work and carpenter shop. In most cases there should be a subdivision of molding and coremaking labor which will show the time consumed by molders and core-

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A paper presented at the Cleveland meeting of the American Foundrymen's Association, September, 1916, and adapted from C. H. Scovell's "Cost Accounting and Burden Application," published by D. Appleton & Co., New York.

makers against individual production orders (and on large work a similar division of cleaning also).

All indirect labor (except that connected with the molding, coremaking, and possibly cleaning departments) should be charged to appropriate burden centers and subsequently distributed to job cost cards on the basis of pounds of good castings made. The indirect labor associated with molding and coremaking will be charged from the labor distribution to the molding or coremaking burden centers, and applied to costs through the hourly burden rate of these centers.

Materials and Supplies

The principal material costs in a foundry are those for pig iron, scrap and fuel charged into the cupola. There is also a considerable expense for molding and coremaking supplies, brick, furnace linings and general items such as heating fuel, building and equipment repairs, etc. The disposition of these miscellaneous charges will be discussed in a subsequent paragraph.

The material charged to the cupola is the principal cost of melted metal, although the total cost of metal is composed of fixed charges on the investment on cupola equipment and raw material inventories, cupola repairs and the labor of the cupola gang. In any well run foundry there is a daily report of materials charged, and weekly and monthly summaries, from which the values of the materials consumed may be readily calculated as a charge to the cost of melted metal.

A perpetual inventory should be maintained for all materials and supplies. This does not necessarily mean that detailed stores cards should be maintained, covering all items of supplies. But separate accounts should be kept (including freight as well as purchase price and unloading costs when kept separate) for such important items as pig iron, scrap, coke, molding sand, etc. General supplies may well be grouped in a storeroom, for which one person should be responsible. The balances on hand may be checked individually as convenient. If various sections of the inventory are checked at regular intervals, a very accurate record can be maintained, so that it is possible to prepare a reliable statement of loss and gain at the end of each period without taking a physical inventory.

It is highly advisable that such supplies as nails, gaggers, etc., be kept under stores control. Large savings have been effected by requiring the foremen of the molding and coremaking departments to issue requisitions for this class of supplies, which are a charge to burden in the respective departments.

Overhead charges or burden are a very important part of the cost of product in an ordinary foundry. Foundry land, it is true, is usually cheap, and the buildings are relatively inexpensive; but repairs are high, especially to cupola and equipment, if they are to be kept in good order, depreciation is rapid, and the current charges for supervision, indirect labor, and supplies, are considerable. It is highly important that the current charges should be allocated and charged to the product accurately.

The natural divisions of a foundry are the cupola and the departments for molding, coremaking and cleaning. A large space may be devoted to pattern storage, and in some foundries, to a pattern shop and a carpenter shop for repairs.

The first burden charge to each department is for rent. In case the foundryman rents his plant from a landlord, the rent chargeable to each department can be determined easily by apportioning the total rental paid among the departments in proportion to the relative areas which they occupy in the factory. In the more common instance, where the plant is owned, the expense corresponding to rent consists of interest and taxes on the land, and interest, taxes, insurance, depreciation and repairs, and possibly heat and light on the buildings. The sum of these charges determined for each building in the plant, divided by the available floor space in each, gives a square foot factor which can be used to distribute the rent charges to departments.

The Equipment Factor

Let us now consider that we have the departments clearly indicated and with the cost of the floor space used by each properly determined. Each department is provided with certain equipment necessary for the operations which it must perform. The burden charges on this equipment will vary, because of the varying cost of the equipment, which affects interest, tax and insurance charges, and because the nature of the operations performed affects the depreciation. Charges of these various kinds are therefore based on the value and kind of equipment in each department. The sum of the rent and equipment charges is fixed whether any manufacturing operations are carried on or not, and are known as fixed charges.

The next charges are for power to drive the machinery and for repairs to keep the factory in good operating condition. The power plant should be considered as an individual unit, and the cost of generating steam and power carefully determined. The cost of operating the power plant will include, beside fixed charges, such items as labor, repairs, coal, water and supplies. Having determined the cost of power, each department using power should be charged with its correct proportion of this cost. If it is not feasible to record the power used by each department, the consumption should be estimated as closely as possible. Multiplying the horsepower hours used by the cost per hour, the power charge against each department is determined.

Handling Expense of Repairs

In a large plant the repair department should also be treated separately, and its burden known. The original estimates on the cost of repairs in departments may be made from repair department records, or from a knowledge of the repair materials purchased, the payroll in this department, and its share of the burden. When work is done for the productive departments such work should be charged to them in the same manner as it would be by an outside company. Including all the elements of cost in the repair charges puts the repair department on a fair comparative basis with outside contractors who would certainly include their burden in making estimates on the cost of work. When the charges are accumulated on the individual repair job they check the estimate in each department.

The labor cost for foremen will be part of the burden of molding and coremaking, and of the pattern shop and carpenter shop, if they are large enough to have charges of this kind. Cleaning labor may all be thrown together and assessed, with other general charges as a cost per hundred pounds on all the work done, but if the foundry is handling large castings which individually take several hours to be cleaned or chipped, these costs should be charged separately just as much as molding or coremaking labor, and in such cases the labor of foremen will be charged to burden as in other departments.

Some foundry executives may question the importance of dividing overhead or burden as above described. They may believe that average costs for metal, molding, coremaking, cleaning, etc., are all that is necessary, and where the product is very uniform, a fairly good control of foundry operations may be secured in this manner.

All foundrymen, however, recognize the widely varying labor costs for molding and coremaking on castings of different weights and different shapes. It is the difference in labor cost that attracts attention, but it takes only a little analysis to show that there is a burden on molding separate from that on coremaking. If an accurate distinction between the cost of light and heavy castings is desired, it is essential to separate the burden costs as well as the labor costs, and charge these burdens in proportion to the work actually done in the respective departments and not as a flat average over the entire output.

Collecting Casting Costs

The elements of cost in a casting are the cost of metal at the spout, and the costs of molding, coremaking and cleaning. There is overhead or burden to be reckoned in connection with all these costs, and there are certain general expenses, as for power, heat and light, and supervision that must be considered and spread in an appropriate way over the product.

These costs will be accumulated on job cards for individual production orders. It is a question of discretion as to just what a production order should cover. In most foundries it will stand for a class of product, or for an individual customer's requirements, but in some instances, as previously noted, individual castings will be made on separate production orders.

A job card should provide for the hours and amount of coremaking and molding labor, pounds of good and defective castings made, and a memorandum as to the loss through returns and allowances. The hours and amount of coremaking and molding labor will be posted from daily labor tickets and the weights of castings, both good and defective, from the daily production reports. A memorandum of loss by returns and allowances will be obtained from the accounting department as credits are issued.

The burden of the coremaking and molding departments will be applied to the corresponding labor charges, preferably on the basis of the productive hours already charged.

If the work is large, cleaning labor and burden will appear as separate items on the individual cards. Any charges for patterns, or machine work that may be done strictly as a foundry cost, will be accumulated on a separate cost card, but should be included on the cost-of-castings card under the heading of "Other Charges".

The cost of metal at the spout as accumulated in the account set up for this purpose is to be distributed to the job cards in proportion to castings made. Some managements will desire to have the material cost of metal and the cupola operating or conversion cost separately on the production orders, but if this division is made, it seems logical to go a step further and show cupola material, labor and burden all separately. The cost of the metal and the cupola operating cost are separate, of course, on the cupola report.

Just what course is adopted in this respect will depend on the view taken in regard to defective castings, and as it cannot always be known whether castings are defective as soon as they are broken out of the sand, it seems wiser to distribute all of the cupola costs to all of the castings made. Those that prove defective have a scrap value. If this is regarded as equal to the average cost of the cupola charge, the cost of the defective casting will be merely the labor and burden (and conversion cost, if stated separately) which has been incurred in their making.

The same result can be secured by distributing the cost of metal on the basis of good castings made and distributing the cupola labor, burden and fuel on the total weight of castings made, both good and defective.

A total will be obtained as to both gross weight and amount, from which the weight only of defective castings will be deducted, if the metal cost is charged on the basis of good castings. If the metal cost is on the basis of gross weight, both the weight and value of scrap will be deducted. According to either plan, this will leave the net weight of good castings, and the total cost of both good and defective, less the scrap value of the defective castings.

General Burden

To the cost, as above determined, general burden should be applied, representing miscellaneous foundry expenses, at a rate per hundred pounds. The main elements of burden in a foundry are to be recognized and distributed as charges on land and buildings, and for power and repairs, but after the best possible analysis of charges of this character, and their distribution to cupola, and to the departments of molding, coremaking, cleaning, etc., some general charges will remain for such items as general supervision, clerical labor, shipping, delivery and the costs of defective castings returned from customers (less scrap value). If the product is fairly uniform and rather small, all the costs of cleaning can be conveniently thrown in the general burden and distributed on a pound basis.

The expense for flasks and patterns, including repairs as well as fixed charges, is logically part of the molding burden, but this is sometimes thrown into general burden.

The policy of different foundries will naturally vary in respect to the cost of new patterns. In a jobbing foundry where the customers own the patterns this factor will not have to be considered, but in a foundry having its own machine shop, it will be considered part of the foundry cost. The general up-keep of patterns may fairly be included in molding burden, but the cost of new patterns should be accumulated on individual pattern orders, even if the final charges are to an expense account.

Patterns are an asset to a certain extent, and if a foundry is rapidly increasing its line, it is logical to increase the asset in patterns, but after a line has been fully established an increase in the assets on account of patterns should be made very cautiously, and practically all expense of this kind charged as maintenance.

Summarizing the Costs

To complete an adequate cost and accounting plan for a foundry, provision should be made for summarizing various records. The distribution of labor and materials and also the development of burden, have already been explained.

The total cost of the cupola will be distributed to individual production orders or job cards, according to one of the two plans previously outlined, and the total will be a credit to the cupola account and a charge to individual orders. A summary of the production orders in respect to labor and departmental burden will provide credits to the respective labor and burden accounts, and the total cost of the finished castings will be charged to an account called "Cost of Goods Sold", by individual customers if immediately shipped, or be transferred to a machine shop inventory. The foundry cost cards should provide for a convenient posting of shipments (weight and cost value), and to carry forward the remaining inventory to the operations of the next period. A few foundries maintain a stock of clean castings that have not been machined, but this is almost uniformly for the benefit of the machine shop rather than the foundry, and the value of such raw castings is much better transferred to the raw material inventory in the machine shop, rather than carried as inventory of finished work in the foundry.

On continuous jobs, such as work for a regular customer, or on any special work that is not finished in the month in which it is started, there will be material, labor and burden costs in the succeeding period in addition to those brought forward from the previous period. The balances, both weights and cost values, determined at the end of each period (month or four weeks) are an inventory of work-in-process, and the total of the balances on the job cards should agree with the controling account in the general ledger. This bookkeeping agreement should be established as a matter of course every period, and a physical inventory should be taken and compared with the job cards from time to time as may be convenient, so that the management may be sure that the values and the weights are actually on hand.

Upon each cost card there should be provision for such information as the selling price, cost of goods sold, gross profit, loss on returns and allowances, and net profit. These items should be proved, by means of summaries, with the controling accounts in the ledger.

With an accounting plan in operation as defined in this article, the management of any foundry can have accurate costs on each class of castings made or sold, know profits on each customer, and have at the end of the month a dependable balance sheet and earnings statement. These results, moreover, can be secured with a surprisingly small amount of clerical labor beyond what is absolutely necessary for the orderly conduct of any business.

So many foundries operate in conjunction with machine shops under the same management, that it seems in order to add a word of caution that the management should always make sure that the costs of operations are equitably divided between machine shop and foundry. This is particularly important to a company that is doing jobbing work in the foundry, besides supplying castings for its own shop. The income from casting sales will naturally be set apart, but unless special care is taken, the charges applicable to the foundry will not be known and determined with equal accuracy.

A foundry that is doing jobbing work is very likely to be in competition with other foundries and while the jobbing business may be desirable to make up tonnage and work the foundry economically, any decision to take business of this kind or let it go should be made only on the basis of accurate information as to what it actually costs and what, if anything, the foundry will lose from unearned burden, if the outside work is dropped.

Cupola Charging

By W. J. Keep

Question:—We recently installed a new cupola which is lined to 40 inches and we are melting approximately 6½ tons per heat. We are using half pig iron and half scrap. Our bed charge of iron is 1,800 pounds, followed by charges of 1,500 pounds each. We would like to know what the coke charges should be for castings weighing from a few to 500 pounds.

Answer:—The weight of the castings, of course, has nothing whatever to do with the coke charge. You should charge sufficient coke to get hot iron. With such a small heat it is advisable to close the entire upper row of tuyeres. It is probable that the maker of your cupola has advised you how much coke to use on the bed. After the coke is fully lighted and all the wood is burned out, and when you begin to charge iron, the bed should extend 15 inches or a little more above the top of the tuyeres. Other charges should be in the ratio of 1 pound of coke to 10 pounds of iron. If the iron comes hotter than you require during any part of the heat, you can reduce the coke charges slightly the next day, or if the iron is too dull, the coke charges can be increased. In this way you will soon arrive at the proper charging figures. For a cupola of this size your iron charges are somewhat large, since charges of 1,000 pounds would be preferable to charges of 1,500 pounds. There is no reason for making the first iron charge larger than the others, although it seems to be common practice to do so, since the more iron you can crowd on a charge, the better the melting ratio.

Book Review

Selling Your Services; board, 176 pages, 5½ x 8¼ inches; published by The Sales Service Co., and furnished by *The Foundry,* for $1.00 net.

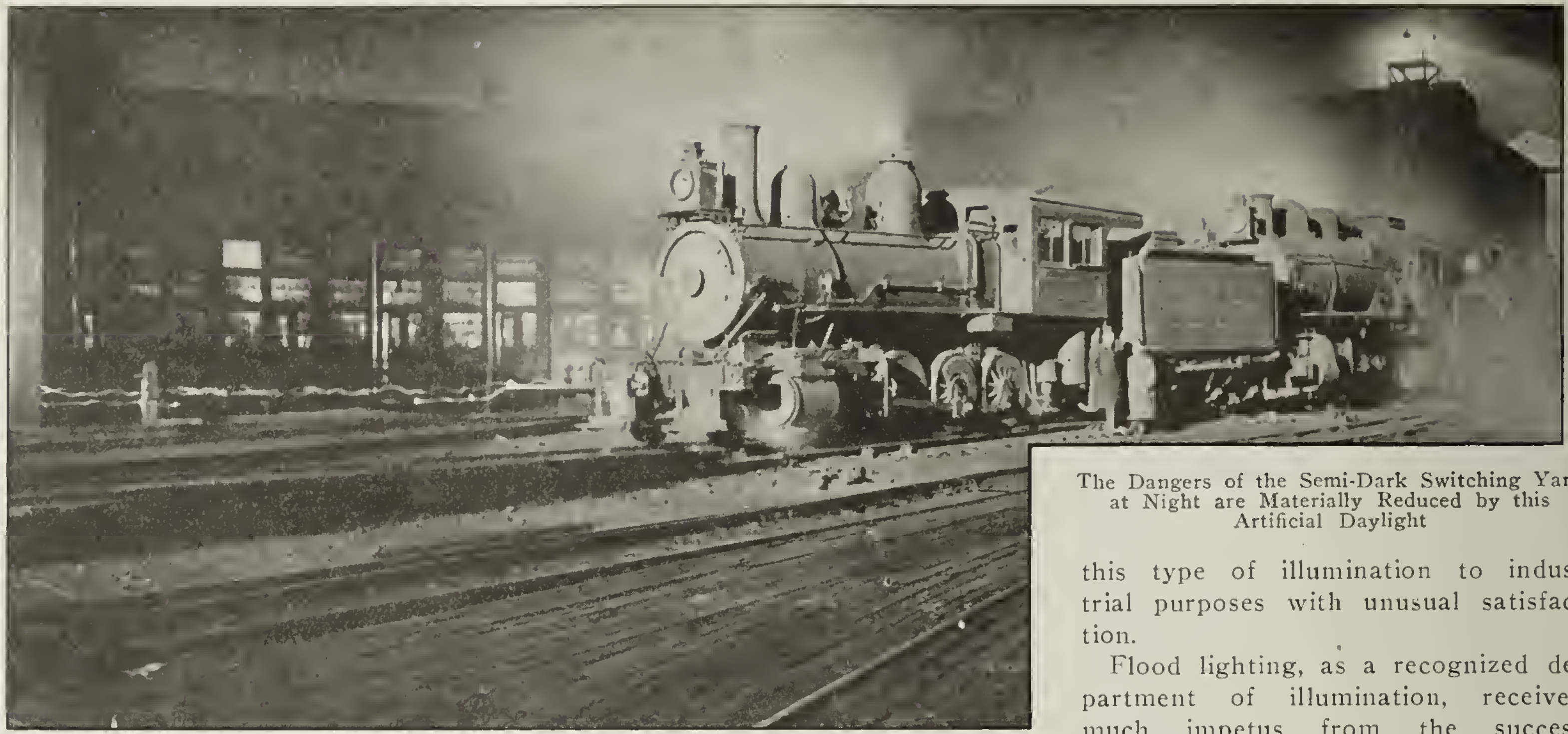
The most effective methods of employing labor is a problem whose solution has occupied a position of increasing importance in the attention of the industrial public in recent years. How to get a satisfactory position, a subject closely akin to the first one and with an equal need of exposition, unfortunately, has played the poor relation in respect to the notice given it. The book under consideration offers itself as a remedy for this omission.

Each man has capabilities which make some particular form of occupation more acceptable than others to him. In the words of the book, "An axiom of life is that a man will be most successful in that field of work which he loves best." *"Selling Your Services"* attempts to make clear to the reader how he can discover this special field for which his talents fit him, and, having discovered it, how he can locate and secure work of the type he desires. The first step is to get, or keep, as the case may be, some kind of work, whether it chances to be of the most congenial type or not. The idea being that an employer looks with more favor on the man with a job who wishes to better his position than on the man without a job who, therefore, has to make bothersome explanations about why he is in that condition. If opportunity for beneficial change exists in the company with which the person ambitious for advancement finds himself, he is advised to stay with that company, as a reputation for business "loyalty" is a great asset to a man. If no such chance does exist, then the means for locating a position which will prove satisfactory must be investigated and the proper persons must be communicated with. It is always considered in better taste not to seek employment from a competitor of your present employers unless your work is of a type which precludes your entering allied industries.

How to find the new position is next considered. If it is to be located by means of a "situation wanted" advertisement, very good advice concerning the form of the advertisement is given. If the applicant is answering a "help wanted" advertisement, equally valuable instructions are given concerning the important points connected with the letter of application. The matter of a personal interview with the prospective employer is discussed next.

The letter written and the visit made, the applicant is advised to keep himself in the mind of the man from whom he desires employment until he gets the position or hears that it is no longer available. The various follow-up methods are described and their methods discussed.

The annual convention of the sales and factory organizations of the Chicago Pneumatic Tool Co., Chicago, was held at the Great Northern hotel, that city, Jan. 11 to 13. The program included a trip to the company's plant at Chicago Heights, concluding with a banquet at the Great Northern hotel on Saturday, Jan. 13.



The Dangers of the Semi-Dark Switching Yard at Night are Materially Reduced by this Artificial Daylight

Use of Flood Lights in Industries

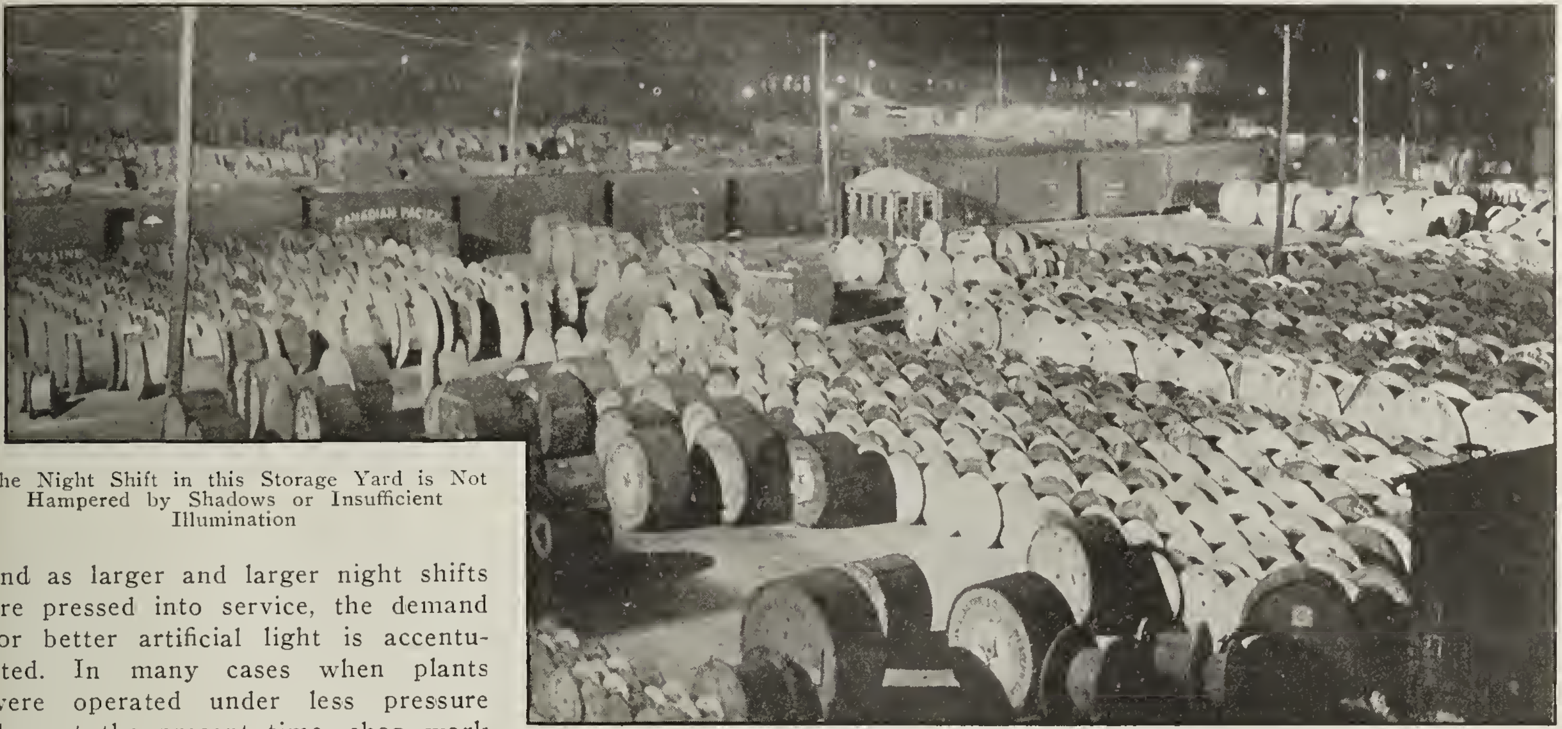
WHEN the flood-lighting units that illuminate the Statue of Liberty were first energized on Dec. 2, 1916, at a word from President Wilson, the successful culmination of three years' effort and development on the part of flood-lighting experts was realized. The beautiful effect of this illumination is certainly commensurate with the importance of the statue as America's most famous monument. While the lighting of Liberty attracted international notice because of the traditions and sentiments connected with it, this installation of flood-lighting units is, of course, but one of hundreds now in operation throughout the United States. The development of suitable lamps and reflectors for this effective type of illumination has led to its adoption for many purposes. The wonderful scenic effects of flood lighting on Niagara Falls, a reproduction of which is shown at the bottom of this page, make that installation worthy of particular mention. The use of light from powerful reflectors to bathe the exterior of buildings and for installations similar to those at the Falls and Bedloe's island, has brought the desirable features of flood lighting to the attention of engineers, who have applied this type of illumination to industrial purposes with unusual satisfaction.

Flood lighting, as a recognized department of illumination, received much impetus from the success achieved at the Panama-Pacific exposition where the buildings, gardens, towers and patios were bathed in beautiful, vari-colored lights from hundreds of concealed projectors. More than 600 acres of the exposition grounds were at night actually made to resemble day. This is the effect, without the decorative frills, that is so desirable for large areas used for industrial purposes. The even, well balanced illumination produced by flood lighting makes its use particularly applicable to storage yards, switching terminals of railroads and to large, open interiors such as foundries.

Good Lighting Increases Production

That good lighting is an important factor in increasing production and in the promotion of safety is a recognized fact. This has been strongly emphasized by the stimulated industrial activities which have characterized the last two or three years. As the wheels of industry are accelerated

THE MAGNIFICENT SPLENDOR OF NIAGARA FALLS IS REVEALED IN ANOTHER PHASE OF ITS BEAUTY BY FLOOD LIGHTING



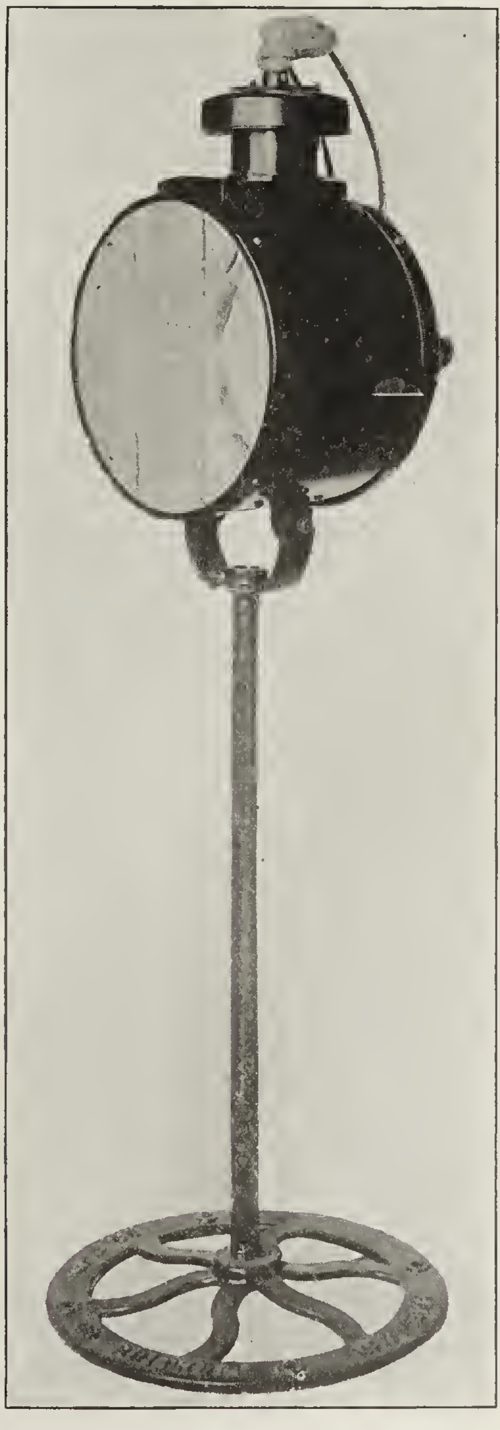
The Night Shift in this Storage Yard is Not Hampered by Shadows or Insufficient Illumination

and as larger and larger night shifts are pressed into service, the demand for better artificial light is accentuated. In many cases when plants were operated under less pressure than at the present time, shop work requiring only local illumination was carried on through the night with satisfaction. By increasing the operating forces working in the storage yards, the products of the night shift could be distributed during the daylight hours. Now, however, with the stress of production so high, all departments of many plants are necessarily operated for 24 hours a day. This condition, therefore, creates the necessity for satisfactory illumination in a number of places not heretofore supplied with artificial light.

Uniform Illumination Without Glare

The illustrations which accompany this article were made from unretouched photographs; they show practical installations of flood lighting equipment in switching yards, storage yards and similar places. Particular attention is called to the uniformity of the illumination, and the absence of strong shadows. It will be noticed that the light which is projected from the reflectors is distributed in a flood of light rather than in solid beam. Such distribution eliminates the disagreeable, and often dangerous, blinding effect which would be noticeable if the light were not diffused properly by the projector.

A type of flood-lighting projector which is used at Niagara Falls and which is used largely for industrial purposes is shown at the right of this page. This projector has been developed by the Western Electric Co., Chicago, and is equipped with a mirrored lens and a 1,000-watt incandescent lamp. The casing of the unit is either cast iron or steel, depending upon whether the lamp is to be used where it will be protected from rain and snow or whether it will be subjected to attacks of all kinds of weather. It is mounted on a hollow pipe standard, which is fastened to a large base of sufficient weight to give the lamp stability without bolting. A swivel joint is provided at the point where the projector is joined to the standard. This arrangement



ANOTHER STOCK YARD AVAILABLE FOR NIGHT WORK—THE PROJECTOR AT THE RIGHT IS EQUIPPED WITH A 1,000-WATT LAMP allows the lamp to be turned conveniently in all directions. Thus, if the lamp is to be used in connection with construction work, it may be set in one place and turned to follow the course of construction as the work proceeds.

Flood lighting has assisted in solving the difficult problem of lighting foundries in a great many cases. At the time of pouring, the smoke rising from the molds tends to obscure the ordinary light sources. By placing flood lights at opposite corners of the foundry and directing their light horizontally across the molding floor above the heads of the workmen, the smoke from the molds is illuminated and in turn reflects the light to the floor below and provides a glareless, uniform light. Such illumination in foundries, especially when molten metal is being handled, tends to reduce the accident liability. The increased efficiency of the men and the attendant increases in production resulting from the use of proper illumination in industrial plants more than compensate for the original cost and small upkeep expense of the equipment.

The Seasoning of Castings

By Richard Moldenke

ONE of the little-known characteristics of cast iron, which nevertheless has an important bearing on results where accuracy in machining is essential, is the ability of this material to ease up internal strains when allowed to remain quiescent for a more or less extended period of time. It seems as if the molecules in such a casting, by virtue of their mobility, can adjust their relative positions to an extent sufficient to overcome some of the existing stresses.

The following instance will perhaps give a fair idea of the condition a casting may be in when just shaken out of the sand. A very large sheave-wheel, after shaking out, was taken outdoors to be cleaned and made ready for turning up. It was leaned against the side of the building, but before much could be done, an arm tore apart with a loud report. Investigation showed that the sun had been shining on the upper rim, thus adding a slight strain to those already existing within the arm and thus overbalancing the strength of the metal in tension. Had this sheave been kept under cover for a while, or at least until machined, the strains would have eased off sufficiently and allowed the sun to look upon it without disaster.

It will not be necessary to multiply examples. Every engineer knows the danger of water-hammer in pipe lines, particularly if the latter are of cast iron. Every mechanic knows, or should know, that it is not good to strike a fitting that is under steam pressure.

Shrinkage and Contraction

It will be necessary to write a few words about the internal strains in castings—the so-called casting strains we hear so much about. It is generally known that to get a casting reasonably true to the dimensions wanted requires a slightly larger pattern. The usual allowance for gray iron is 1/8 inch to the foot and 1/4 inch to the foot for white iron. This reduction in length, breadth and thickness in a casting is erroneously called shrinkage. It should be called contraction, as for practical purposes it is simply the difference in dimensions of the casting red-hot and cold. In fact, it is really a volumnar contraction, and takes place after the metal has set.

The real shrinkage covers an entirely different situation. When a casting is poorly designed, it is impossible to feed the mold properly when pouring. The thinner sections set more quickly than the thick ones and may leave the latter without means of drawing in liquid metal to compensate for the reduction in volume in the act of setting. As the metal sets against the mold walls first, and gradually thickens from the surface inward, when the influx of fresh supplies is stopped there results a void in the center, or at least a spongy portion. This is shrinkage, and can be seen more particularly in white iron, by reason of its greater reduction in volume from liquid to solid form, apart from the final contraction from red heat to ordinary temperatures. Such shrinkage usually takes place at abrupt angles, in thick parts adjoining thin ones, in the rims of flywheels, hubs of pulleys, at the flangers of cylinders, etc.

It will be seen from the above that there are really two kinds of reduction in volume to be reckoned with: *First,* that due to the change from the liquid to the solid state; *second,* the reduction in volume after setting until ordinary temperatures have been reached. The first, often called interior shrinkage, is a rather serious occurrence. The specific gravity of molten iron is about 6.65; it does not vary widely from this figure whether the metal on setting is gray or white in fracture—all the carbon being combined when in the molten state. On setting, however, if gray iron results, the specific gravity will be over 6.8, and if white iron, up to 7.8. The formation of graphite in the structure accounts for the comparatively moderate increase in the case of gray iron. In average cast iron with 7.3 specific gravity, the increase in density is 0.65, or 9 per cent, which means a very big decrease in volume for equal weights of molten and solid metal. This situation accounts for the quantities of molten metal that have to be added to a mold after pouring it full in the first place, and in the case of small castings, particularly when of white iron, for the funnel-shaped sprue left in the pouring basin or gate.

Interior Strains Reduce Tensile Strength

Contrast this with the eventual reduction in volume after setting. Here we have a linear reduction of about 1 per cent in every direction, which is an infinitesimal amount when compared with the real metal shrinkage.

It stands to reason that if the metal in setting has the power to pull apart, whatever liquid material may remain after feeding has stopped, thus causing large, spongy parts in the interior of a casting; powerful strains which affect the strength injuriously must have occurred. This is apart from the reduction of strength in the material for the section itself. In other words, not only will the metal have a lower tensile strength because of the spongy nature of part of the section, but the interior strains counterbalance part of the tensile strength that is available.

This situation is intensified by the fact that the metal in setting does so far more quickly at the mold surface than in the interior—the cold sand walls drawing away the heat from the molten iron more quickly at the beginning of the setting process than later when this heat has to travel through a more or less thick shell of metal already set. The consequence is a higher percentage of combined carbon at the surface than in the interior of the casting. In chilling the surface, we have a white

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A paper presented at the New York meeting of the American Institute of Mining Engineers, February, 1917. The author, Richard Moldenke, is consulting metallurgist, Watchung, N. J.

THE FOUNDRY DATA SHEET, MARCH, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

CUBIC FEET OF AIR AT 65 DEGREES FAHR. HANDLED PER MINUTE THROUGH AVERAGE DUST-COLLECTING HOODS

From Information Furnished by B. F. Sturtevant Co., Hyde Park, Mass.

(Based on Coefficient of Orifice of 0.71 with 10 Per Cent Added for Leakage.)

Diameter of connection pipe, inches	Maintained Suction—Inches Water Gauge							
	1	1½	2	2½	3	4	5
1½	38	47	54	61	67	76	86
2	68	84	97	108	118	136	153
2½	107	131	161	168	185	214	238
3	153	188	217	243	266	306	343
3½	209	256	296	330	362	418	466
4	273	334	386	431	473	546	609
4½	345	423	488	546	598	690	775
5	427	523	605	676	741	854	955
6	614	751	867	970	1,062	1,228	1,373
7	835	1,023	1,181	1,322	1,448	1,670	1,870
8	1,092	1,337	1,546	1,727	1,892	2,184	2,440
9	1,381	1,694	1,953	2,184	2,387	2,762	3,091
10	1,705	2,090	2,409	2,695	2,959	3,410	3,806

CONNECTION PIPES FOR GRINDING AND POLISHING WHEELS

From Information Furnished by B. F. Sturtevant Co., Hyde Park, Mass.

The sizes of connections suggested for grinding and polishing wheels are those given in the tables by the department of labor of New York, with the exception of those for polishing wheels 21 inches and over in diameter.

MINIMUM SIZES OF BRANCH PIPES FOR EMERY OR OTHER GRINDING WHEELS

Diameter of wheels	Maximum grinding surface square inches	Minimum diameter of branch pipe in inches
6 inches or less, not over 1 inch thick	19	3
7 inches to 9 inches, inclusive, not over 1½ inches thick	43	3½
10 inches to 16 inches, inclusive, not over 2 inches thick	101	4
17 inches to 19 inches, inclusive, not over 3 inches thick	180	4½
20 inches to 24 inches, inclusive, not over 4 inches thick	302	5
25 inches to 30 inches, inclusive, not over 5 inches thick	472	6

MINIMUM BRANCH PIPES FOR BUFFING, POLISHING OR RAG WHEELS

Diameter of wheels	Maximum grinding surface square inches	Minimum diameter of branch pipe in inches
6 inches or less, not over 1 inch thick	19	3½
7 inches to 12 inches, inclusive, not over 1½ inches thick	57	4
13 inches to 16 inches, inclusive, not over 2 inches thick	101	4½
17 inches to 20 inches, inclusive, not over 3 inches thick	189	5
21 inches to 27 inches, inclusive, not over 4 inches thick	338	6
27 inches to 33 inches, inclusive, not over 5 inches thick	518	7

Where the branches are extremely long, the friction loss in the system may be decreased by making pipes ½ inch greater in diameter than the sizes given in above tables.

THE FOUNDRY, DATA SHEET NO. 229, MARCH, 1917

SIZES OF CONNECTIONS FOR WOOD-WORKING MACHINERY

From Information Furnished by B. F. Sturtevant Co., Hyde Park, Mass.

Type of machines	No. of connections	Diameter of pipe, inches
Swing saws: Small size on dry kiln lumber, large on wet	1	3½ to 6
Rip saws: Dry kiln material	1	4
Not dry kiln material	1	4½
Self-feed saws	1	5
Table saws:	1	4
For box factory work	1	4½
Mitre saws	1	4
Variety saws	1	4
Variety saws with dado head	1	5
Double saws	2	5
Gang saw (Dependent on size and number of saws)	.	6 to 9
Band saws:		
Blade under 2 inches wide	1	4
Blade 2 inches to 3 inches	1	5
Blade 3 inches to 4 inches	1	6
Blade 4 inches to 6 inches	1	7
Blade 6 inches to 8 inches	1	8
Jig saws	1	4
Tenoning: Single head	1	5
Double head	2	7
Double end double head	4	10
Variety moulder or shaper: Single head	1	4½
Double head	2	6
Double head, heavy work	2	8
Sanders:		
Belt—Less than 6 inches wide	1	4½
Belt—6 to 8 and 10 inches wide	1	5
Belt—12 and 14 inches	1	6
Drum—24 inches long	1	4
Drum—30 inches long	1	5
Drum—36 inches long	1	6
Drum—48 inches long	1	8
Drum—Over 48 inches	1	10
Disc—24 inches diameter	1	5
Disc—26 inches to 36 inches	1	6
Disc—36 inches to 48 inches	1	7
Arm sander	1	4
Planers, matchers, moulders, stickers, jointers, etc. (all top and bottom heads).		
Knives 6 inches to 8 inches	*	5
Knives 9 inches to 14 inches	*	6
Knives 15 inches to 20 inches	*	7
Knives 22 inches to 26 inches	*	8
Knives 28 inches to 36 inches	*	9
Side knives under 15 inches	*	4½
16–20 inches	*	5
21–24 inches	*	6

*One hood for each cutter.

The above table gives the sizes of connections commonly used with wood-working machines, but it is not intended to restrict the pipe to these diameters, as the size varies with the quantity of shavings, the kind of lumber, its condition, whether wet or dry, and the variation in speed of the cutter heads. Modern high-speed machines require larger connections than older types, even though the cutters be of the same size. Experience will dictate just what increase is necessary.

THE FOUNDRY, DATA SHEET NO. 230, MARCH, 1917

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

iron surface and a gray iron interior. The relative change in the specific gravities of the same molten iron turned into two extreme forms of iron as cast will indicate what strains there must be within the casting due to the differences in volume which the two metals want to occupy when set, but cannot properly occupy on account of the quickness of the setting action.

Finally come the strains due to the contraction in the set material until ordinary temperatures have been reached. This has been stated as ⅛ inch to the foot in gray iron and ¼ inch to the foot in white iron. In large castings this is very serious. Suppose, in the case of a big flywheel, the rim sets fast enough to hold the much cooler arm as in one set of jaws of a testing machine, the hub, held by the arms on the other side of the wheel, being the other set of jaws. Surely the arm in wanting to reduce in length ⅛ inch to the foot must be under a terrific strain if not allowed to do so. In the case of white iron the situation is much worse. Such castings as hand-brake wheels (subsequently annealed for malleable castings) snap apart when allowed to cool in the sand in the ordinary way. Work of this kind must be shaken out as quickly as set, taken to special ovens and allowed to cool down very gradually.

Sufficient has been said to make the case of cast iron look very weak. Fortunately, there are two phenomena which help to overcome some of the injurious strains set up. The first is the fact that cast iron in the act of setting (between liquid and solid) can be stretched. The second is the seasoning or easing up of the remaining strains after the final contraction through the mobility of the molecules. It is the stretching of gray iron during the setting that saves the flywheel arm from rupture before the new strains due to final contraction are introduced. It is the inability of white iron to stretch very much, which causes so many cracked castings in the malleable process which would not be seriously affected by the final contraction.

Test Guarantees Unfair

This discussion of the actual situation in making castings has another bearing. Purchasers of castings may wonder why foundrymen who really know something about their basic material are so uncompromisingly opposed to test coupons on their product. The man who is at least somewhat familiar with cast iron should realize that it is unfair to the maker of the casting to judge its value by a test piece subject to a variety of strains introduced as the result of position, manner of attachment, method of pouring of the metal, etc. It is further unfair to the purchaser to judge by coupons, as there are many ways of artificially strengthening such test pieces. There is only one way of testing a casting properly, and that is to break it. Obviously this will not do, and hence for repetition work a given percentage of castings can be thus tested. For all other cases the only method of obtaining reasonable assurance on the subject is to make standard test bars, entirely apart from the castings, but of the same iron. These test bars should be made under conditions giving the iron the best possible chance to show just what it is, neither artificially strengthened, nor filled with strains and thus deliberately weakened.

Every mechanic knows that in planing up a slab of cast iron on both sides to get a true job, it is necessary to take a light cut, reverse, and take a cut on the other side, then reverse again for the finishing cut, finally reversing for the last cut. If this is not done, there will be warped surfaces to deal with on account of the internal strains. Again, it is well known that a true piston is rather difficult to produce. Even after grinding to a finish, it is apt to get out of true. It is not so generally known, however, that if such a cast iron plate or piston is allowed to remain in storage for a long period, the results will be much more satisfactory. The castings have seasoned. Where establishments are familiar with future production demands, orders for castings are placed far ahead of requirements. Since, however, on getting to the bottom of a big pile the difficulty of tracing defective work becomes correspondingly harder, only shops having their own foundries are likely to do much storing.

The present demand for very high-class machined castings, as evinced by automobile cylinders, pistons, engine and compressor cylinders, etc., should bring this question of seasoning out very prominently. Inquiry by the writer has shown but little knowledge on the subject in the trade generally, though first-class foundrymen were very much alive to the matter. In general, the difficulty seems to be the inability of storing up ahead, or, if this is done, of discovering defective product when least expected.

We are indebted to the well-known metallurgist, A. E. Outerbridge Jr., for what seems to be the best indirect explanation of seasoning. In his famous experiments on tumbling castings to increase their strength, he found that by the action of light blows, often repeated, the internal strains were relieved to such an extent that the real value of the metal came into play. The mobility of the molecules was aided by artificial means. Incidentally, however, the tests establish the mobility of the molecules in cast iron very satisfactorily. Replace half-an-hour's tumbling by six months' quiescence and the molecules will have done their work with somewhat the same results.

In view of the possible depression scheduled for this country on the close of hostilities in Europe, would it not be well to ease up operations slowly instead of shutting down tight? This would help the industrial situation adjust itself more safely and at the same time permit supplies of castings to accumulate, which will be all the better for having seasoned.

SLOW MELTING AND BRIDGING

By W. J. Keep

Question:—Slow melting and bridging is the difficulty we are experiencing with our cupola which has a 60-inch shell and is equipped with special tuyeres. It is absolutely essential that we have hot iron, since we do a large amount of cylinder work and the iron must be carried a considerable distance before pouring. However, after seven or eight tons have been melted, the iron begins to get dull. The tuyeres have given excellent satisfaction on small heats, but on large heats bridging occurs. We have boshed the cupola to accommodate this style of tuyeres. Up to a few months ago our heats averaged 14,000 to 16,000 pounds, when no trouble was experienced, but the melt is growing from day to day and our difficulties are increasing in proportion. Our coke bed extends 24 inches above the upper tuyeres and the bed charge of iron consists of 2,500 pounds and the succeeding charges are 1,600 pounds of iron to 200 pounds of coke. Several days ago we made a heat of 22,500 pounds. The blast was put on at 3:15 p. m. and the bottom was dropped at 5:35 p. m. The heat required two hours and 20 minutes and we would like to cut down this time if possible. I would like to know whether I can use a straight lining. While the cupola has a shell diameter of 60 inches, 4-inch brick is used for lining, making the cupola diameter 52 inches. Also, would you suggest a single row of tuyeres with nearly continuous openings about 4 inches deep, 12 inches wide next to the shell and flared to 18 inches at the lining? At present, the cupola is provided with 11 lower tuyeres, 7 x 3½ inches and six upper tuyeres, 3 x 3¼ inches. The blast is furnished by a fan, being delivered through a 15-inch blast pipe. The blast gage records 11 ounces at the beginning of the heat and 12 ounces at the middle of the heat. We have tried slagging, having used about 20 pounds of limestone on each charge, but the slag was not fluid enough to run freely. I was afraid to use more, fearing the formation of excessive slag. At present we are using only a small amount of limestone, sufficient to make the slag brittle. All of our sprues are milled, since we believe it advisable to keep all slag-forming materials out of the furnace. I personally inspected the cupola in the morning and a mass of coke and slag covered the lining between the lower and upper tuyeres. Within two or three weeks we expect to increase our heats to 28,000 pounds and, therefore, it is essential that we eliminate our difficulties as soon as possible.

Answer:—It would be advisable to refer this problem to the maker of this peculiar type of lining. We are using cupolas of the same size and practically the same lining, but with only one row of tuyeres. Some time ago our melting ratio was published in these columns, which represented the consumption of one pound of coke to 9½ pounds of iron for a 28-ton heat melted at the rate of 12 tons per hour, but we were requested to withdraw the statement by the party who recommends this special lining, since he did not believe that this could be done. The same thing can be accomplished with a straight lining, but similar results can be obtained with the boshed lining which you have. You certainly can get along with less bed coke with a boshed cupola. If your lower tuyeres are continuous and 3½ inches high, you will probably get enough air. The thin iron supports from the tuyeres can be set back slightly. It might be advisable to close the upper tuyeres with a thin piece of brick. When you begin to charge iron, see to it that the coke extends 18 inches above the top of the lower tuyeres if the upper tuyeres are cut out. Be sure that you light your fire two hours before the iron comes down, so that the cupola is hot enough to melt iron when charging begins. Be careful to avoid charging sweepings either from the foundry or the charging floor.

Your cupola should be slagged after the first three charges, or before if the slag will run. Be sure that you are using good limestone and not dolomite. Use enough of this flux to produce a fluid slag, 20 pounds not being sufficient, since it will probably take from 40 to 60 pounds. You should not allow the slag to remain in the cupola. Your blast pipe is small and you may have some sharp bends in it. The best way is to learn to use what you have, before you make extensive changes.

Making Large Pure Aluminum Castings

Foundrymen who have attempted to cast pure aluminum realize the difficulties involved in this work. Recently the Sheeler-Hemsher Co., Philadelphia, received an order for pure aluminum castings of large size, which were made without cracks or draws and which developed no unusual shrinkage spots. A number of these castings are shown in Fig. 1 and an enlarged view of one of these cylinders is illustrated in Fig. 2. This cylinder weighs 350 pounds, has an outside diameter of 42½ inches with 2-inch flanges inside and outside, consisting of ¾-inch. metal. The remarkable feature of this work is the fact that a dry sand core was used and it was believed that possibly the cylinders would crack in cooling. However, the first attempt proved successful and all of the castings passed a rigorous inspection.

Annual Meeting of Testing Society

The 20th annual meeting of the American Society for Testing Materials will be held at Atlantic City June 26-30, with headquarters at the Hotel Traymore. That this watering place is favored by the large majority of the members of this organization is indicated by the results of a vote taken several months ago to select the time and place for the next annual gathering. Out of 453 ballots cast, Atlantic City was favored by 256, Chicago 56, New York 42, Washington 18, Pittsburgh 17 and scattering 64. Two hundred and seventy-six members favored June, of whom 175 named the last week of that month. Notwithstanding the increase of 50 per cent in dues, which became effective Jan. 1, 1916, the growth in membership has been well maintained, the net increase for last year having been 171, as compared with 208 the previous year. The present total membership is 2,132, which represents a net increase of 62, as compared with the figures reported at the last annual meeting.

The Federal Foundry Supply Co., Cleveland, received a contract from the United States Navy Yard to supply all of the graphite used by its foundries in 1917.

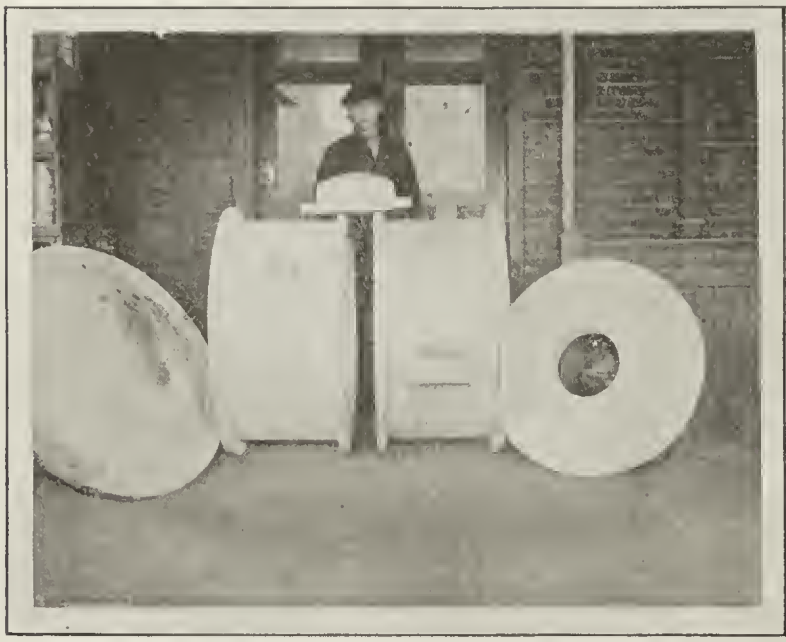


FIG. 1—PURE ALUMINUM CASTINGS OF LARGE SIZE MADE BY THE SHEELER-HEMSHER CO., PHILADELPHIA

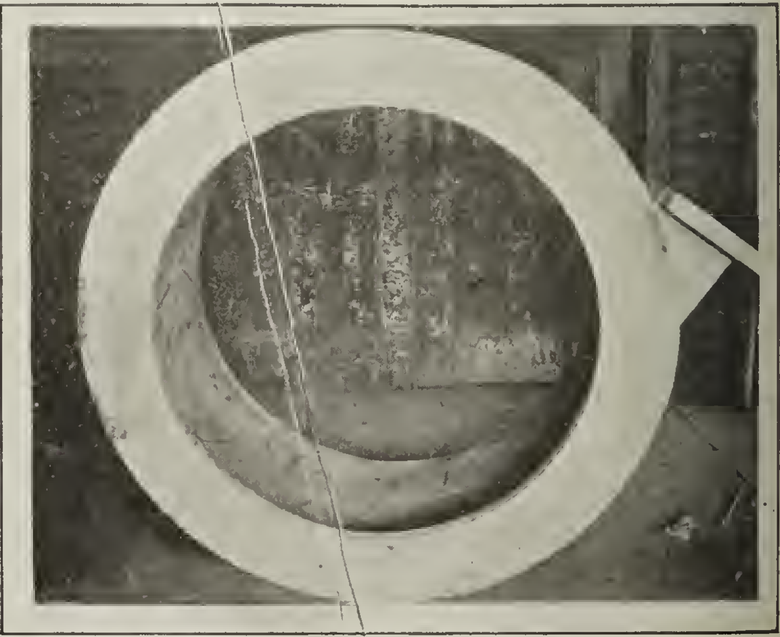


FIG. 2—ANOTHER VIEW OF ONE OF THE CYLINDER CASTINGS MADE SUCCESSFULLY BY THE USE OF A DRY SAND CORE

Molding Wheels and Sheaves With Steel Spokes

How to Properly Arrange the Mold and Place the Gates so That the Contraction of Various Parts of the Casting is Equalized

By R H Palmer

MANUFACTURING steel spoke wheels and sheaves is attended with an unusual amount of difficulty, and unless the foundryman who attempts to make castings of this kind has had considerable experience in this line of work, his efforts undoubtedly will be unsuccessful. To insure satisfactory results, certain fundamental principles in the preparation of the mold and the pouring of the metal must be followed. The operations to be outlined in this article constitute the practice followed in a plant where wheels and sheaves have been manufactured successfully for many years.

Fig. 1 shows a common type of wheel varying in diameter from 6 to 10 feet. The rims weigh from 2,000 to 8,000 pounds and the hubs range in weight from 600 to over 2,000 pounds. The steel spokes are about 1¾ inches in diameter.

When molding a wheel of this type, it is much more convenient to use cores to form the hub and the rim than to make the mold in a flask. The first operation involves the forming of a bed of green sand which is leveled as shown in Fig. 2. The bottom core, A, for the hub, and the bottom cores, *BB*, for the rim then are placed in position. The cores for the rim are made in sections and contain half circle indentures for the steel spokes, the same as the bottom hub core. The rim cores and the outer ends of the spokes are set up to the sweep, as shown in Fig. 3, to insure a perfect circle. After the lower spokes are set in place, the hub cores, *C* and *D*, are inserted, after which the upper tier of spokes is placed in position. The upper cores, *EE*, which are identical with *BB*, and the upper hub core, which is similar to *A*, are then added to the mold and securely clamped to the lower cores.

Fig. 5 shows the completed mold; *B* indicates the lower rim cores which form the inside of the rim. It will be noted that the outer edge of the rim is formed by green sand placed between the wooden segment *F* and the curbing, *G*. Seacoal facing is used between *F* and *G* to the height of the cores. Flat cores, in the form of segments, are placed on the mold to cover the rim, and the joints between these segments are covered with paper over which loose sand is thrown. The mold is weighted with pig iron to hold the cores in place.

The arrangement of the gating and heading of the mold is illustrated in Fig. 5. A large pouring basin is provided for the metal for the rim and a riser at the other side of the wheel furnishes a means of feeding the rim which is poured one day, and the hub the following day.

Foundrymen who have been accustomed to making light castings are liable to question the practice of feeding the rim. Experience has shown that rims of this kind, having a large cross-section, will sink down in the center, show signs of sponginess and will contain holes in various places unless provision is made for supplying hot metal to the inner portion of the casting as it cools. To supply the molten iron to the casting and to keep up its volume while passing from the molten to the solid state, it is necessary to provide a large riser. This riser, with the aid of a feeding rod which keeps open the path from the riser to the fluid metal in the casting, enables the foundryman to keep hot iron flowing into the casting, thereby preventing a loss in the volume of the section due to

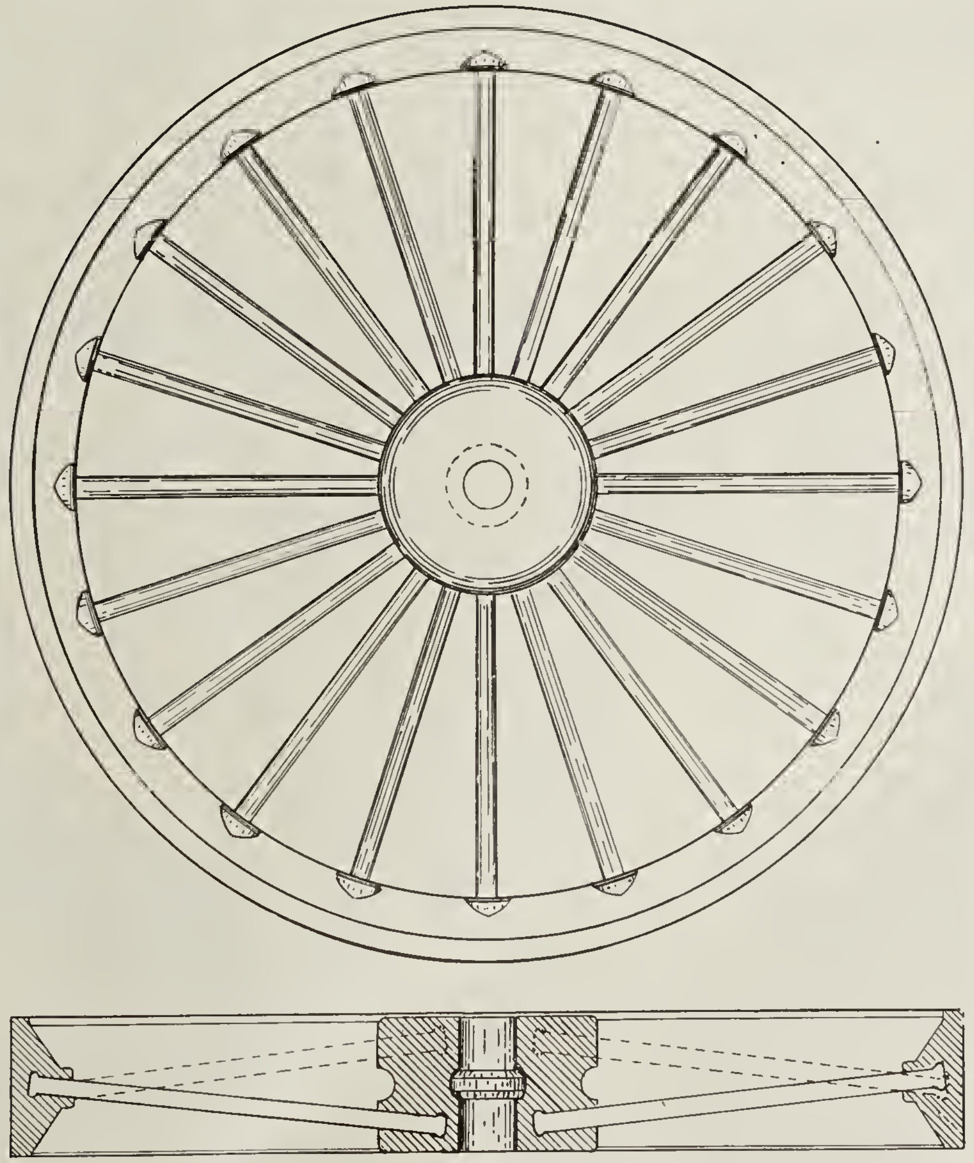
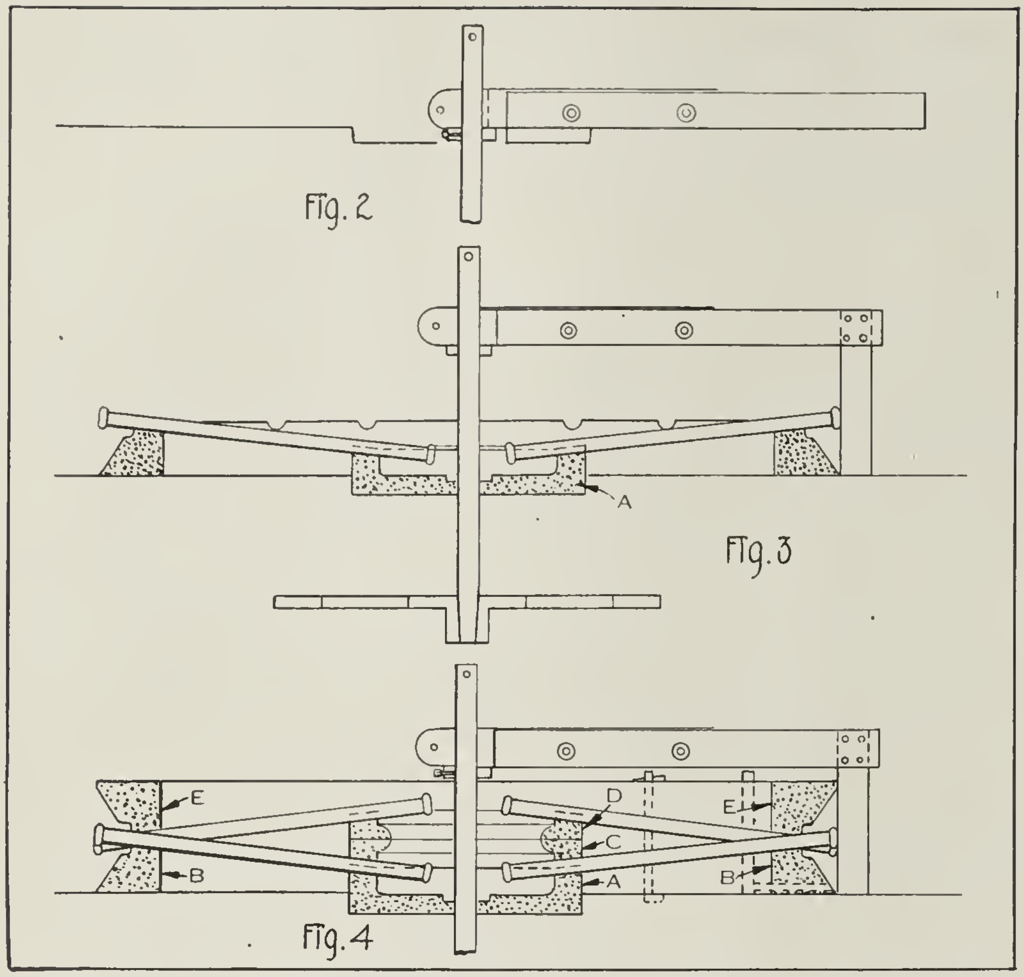


Fig.1

FIG. 1—A COMMON TYPE OF WHEEL HAVING STEEL SPOKES



FIGS. 2, 3 AND 4—SUCCESSIVE STEPS IN BUILDING-UP A MOLD FOR A WHEEL OF THE TYPE SHOWN IN FIG. 1

contraction. It has been found that a coating of silicate of soda, commonly known as liquid glass, has a beneficial effect upon the ability of the metal to firmly adhere to the steel spokes. As an indication of this, an interesting experiment may be cited. A band of cast iron, 4 inches thick and about 8 inches in diameter, was cast around a 1⅞-inch steel shaft. The shaft had been thoroughly cleaned and the metal was poured at white heat. It required a pressure of five tons on a hydraulic press to move the cast iron on the shaft. A second piece of the same shaft was cleaned and coated with silicate of soda, and a casting of the same size as in the first trial, was cast around the shaft. When placed on the press, a pressure of 35 tons was required to slip the casting on the shaft.

The analysis of the iron used in making the rim of the wheel of the type mentioned, follows: Graphitic carbon, 2.416 per cent; combined carbon, 0.780 per cent; silicon, 1.760 per cent; sulphur, 0.096 per cent; phosphorus, 0.578 per cent, and manganese, 0.52 per cent.

Designs of Rim Vary

The mold of a wheel similar in many respects to that shown in Fig. 1, but with a rim of different design is illustrated in Figs. 6, 7, 8 and 9. Wheels of this type range in diameter from 6 to 10 feet and have steel spokes 1 inch in diameter. The rims vary in weight from 700 to 3,600 pounds and the hubs from 400 to 1,800 pounds.

In preparing the mold for a wheel of this kind, the bed of green sand is leveled an indicated in Fig. 6, and the hub core, *A,* and the runner or gate cores, *BB,* are placed in position. Sand is then rammed level to the top of the gate cores in the space between the cores. This forms the bed on which are placed the lower halves of the core forming the inside of the rim. This sand bed also forms the inside edge of the mold below the rim cores. The center and top hub cores, and the steel spokes are assembled in the mold in the manner previously described. A segment similar to *F,* Fig. 5, then is placed against the inside of the rim and sand is placed on top of the top halves of the rim cores and between this pattern segment and the outer curbing of the mold, as indicated in Fig. 8.

Mold is Open at Top

The arrangement of the mold and the method of pouring differs from that previously outlined, the top of the rim being left open, eliminating the necessity for providing risers. As the metal is poured into the large pouring basin and

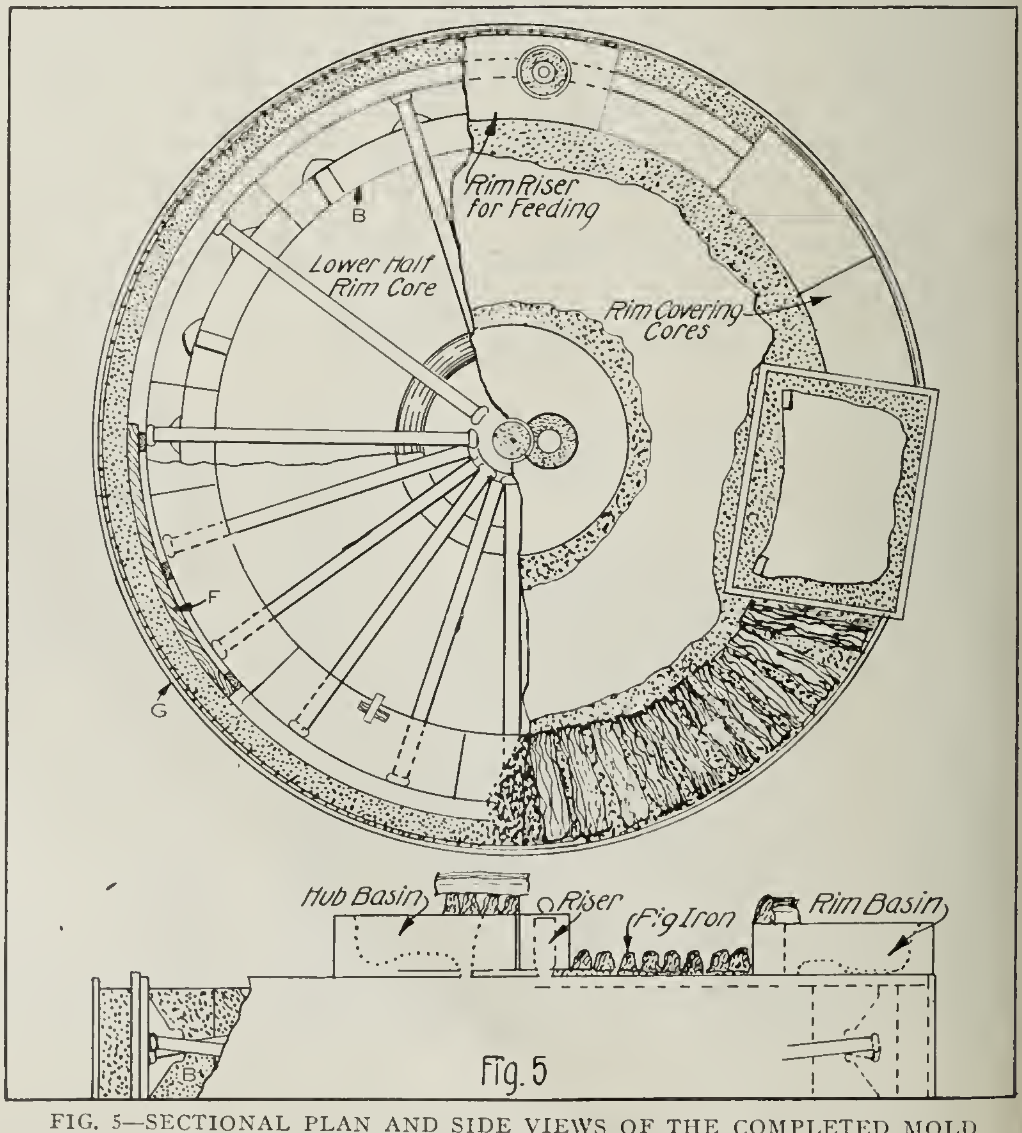


FIG. 5—SECTIONAL PLAN AND SIDE VIEWS OF THE COMPLETED MOLD FOR A WHEEL WITH STEEL SPOKES OF THE TYPE SHOWN IN FIG. 1

is fed to the mold through the gate leading to the bottom of the rim, men are stationed around the mold to guide the dirt and slag in the rising metal, by means of rods, to the top of the rim. Since the mold has been extended to a height to allow for this top edge of dirty metal, sufficient stock is provided to permit of machining off this undesirable metal.

Method of Gating Important

In this mold, the method of gating has a great influence upon the behavior of the metal while cooling, and consequently affects the shape of the casting. Fig. 8 indicates the gating arrangement that was employed for many years in making these wheels. The metal was poured into the large basin from which it flowed through the gates to the bottom of the mold where it entered the rim. The metal flowed around the rim until the two streams of metal met at the lower part of the rim at the side opposite the pouring basin. Naturally, at this point, the metal in the mold was more sluggish than that near the gate on the other side of the wheel, and this difference in temperature was made more pronounced by the chilling effect of the steel spokes upon the molten iron. The metal, at the side farthest from the gate, cooled much more rapidly than that below the pouring basin, and as a result the iron was harder at that point. Moreover, on the morning following the day on which the metal was poured, it was invariably discovered that the rim on the side opposite the gate had crept closer to the center of the wheel, as indicated by the dotted lines at *X*, Fig. 7. The gate, firmly held by the surrounding sand, served to prevent the pouring side of the rim to contract toward the center, thus accounting for the eccentric form of the wheel.

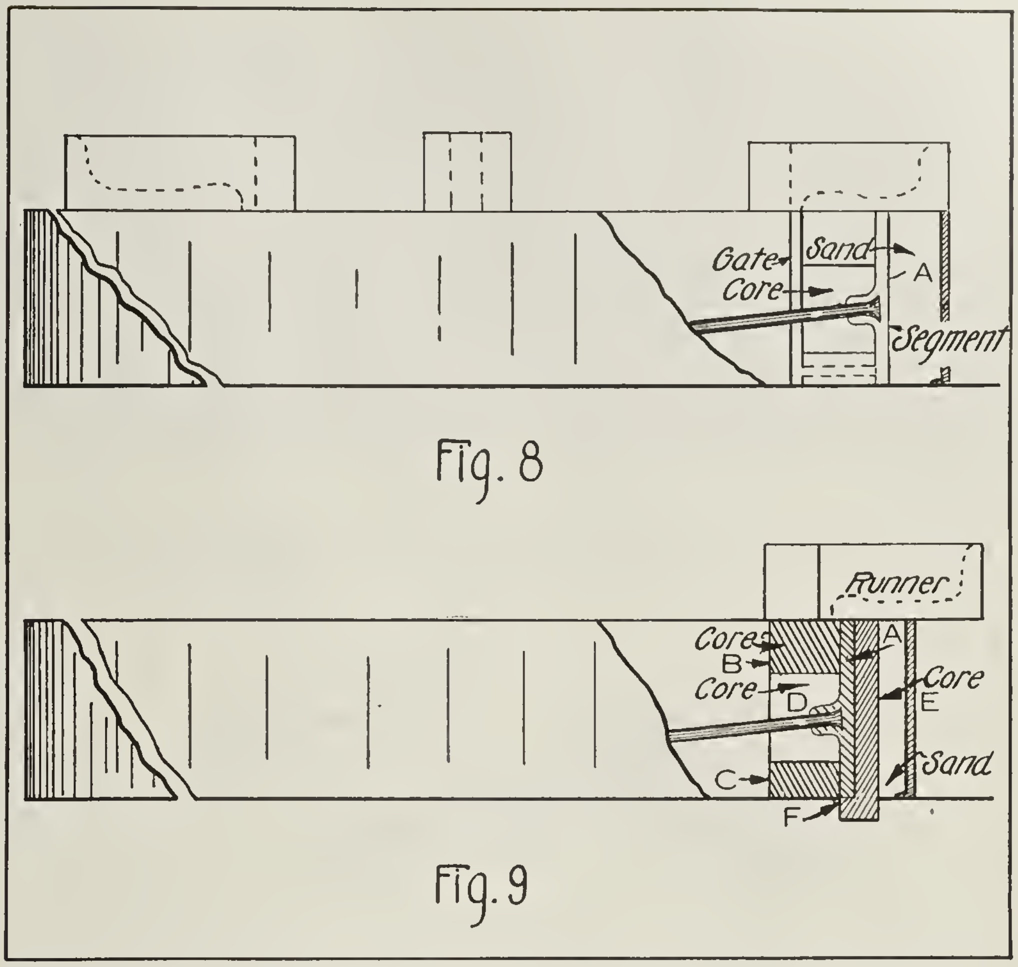


FIG. 8—A POOR METHOD OF GATING THE RIM. THE SPRUES PREVENT AN EVEN DISTRIBUTION OF THE SHRINKAGE STRESSES. FIG. 9—SATISFACTORY METHOD OF BUILDING-UP RIM MOLD

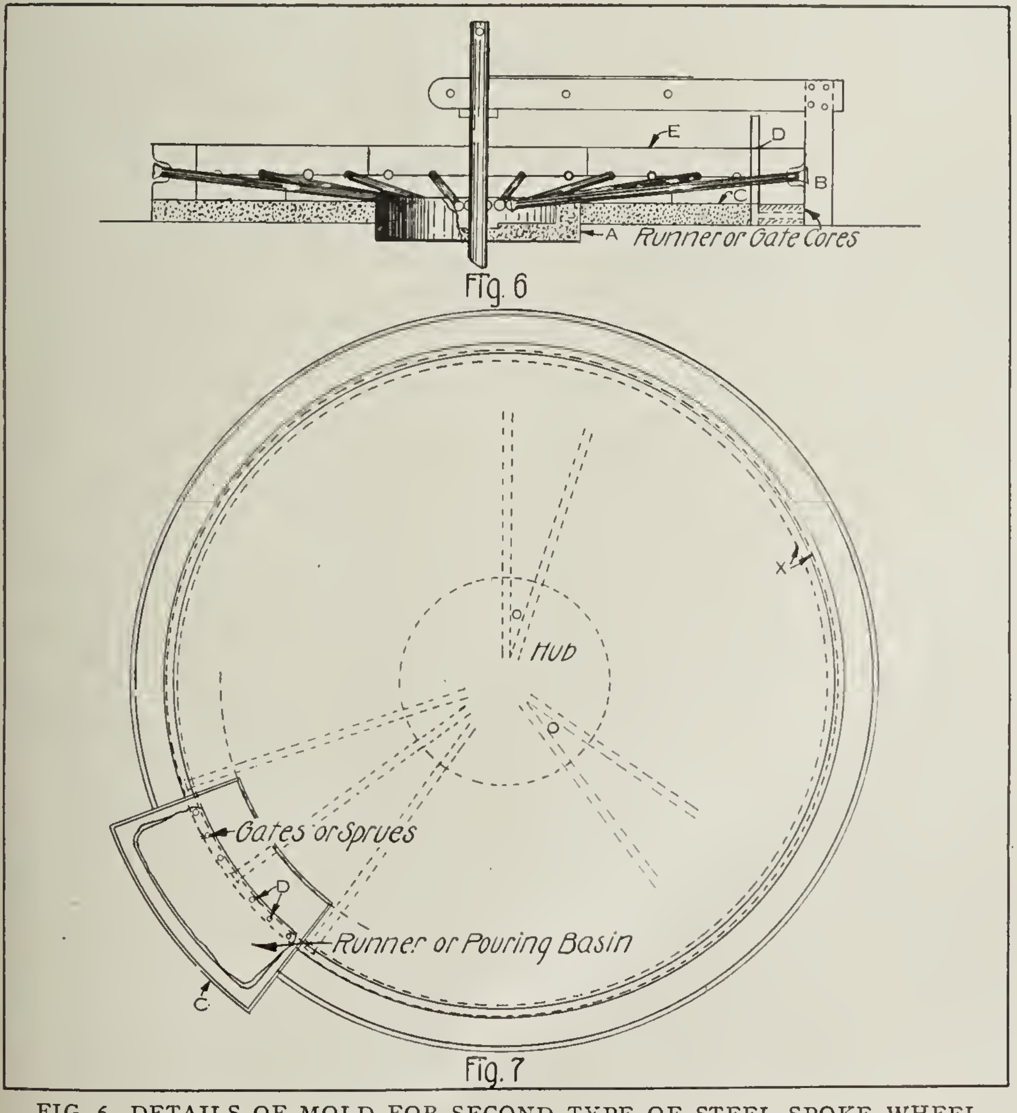


FIG. 6—DETAILS OF MOLD FOR SECOND TYPE OF STEEL SPOKE WHEEL FIG. 7—PLAN OF MOLD. DOTTED CIRCLES SHOW ECCENTRIC RIM RESULTING FROM IMPROPER METHOD OF GATING

How to Equalize Contraction

The second, and preferable method of gating this casting, involves the use of cores for forming every part of the rim. The two cores which form the inside of the center of the rim are the same as those used in the other pouring arrangement, but instead of sand supplementing these cores, additional cores, as shown in Fig. 9, are employed. The outer and bottom faces of the rim are formed by a core with a lip on the bottom, extending underneath the casting to the core which forms the lower inside face of the rim. The pouring gate, in this instance, distributes the metal to the mold through a number of gates leading directly into the rim. These gates are spaced between the ends of the steel spokes, as shown in Fig. 7. When pouring, sheets of perforated tin are placed over the hole and the pouring basin is filled as rapidly as possible. The metal is held back by the tin long enough to allow the dirt to rise to the top of the mold, and thus clean metal drains directly into the mold.

The hub should be poured on the side opposite that from which the rim was poured. A good mixture for the rims of wheels, similar to the one described, follows. Graphitic carbon, 2.536 per cent; combined carbon, 0.820 per cent; silicon, 1.680 per cent; sulphur, 0.086 per cent; phosphorus, 0.540 per cent, and manganese, 0.520 per cent.

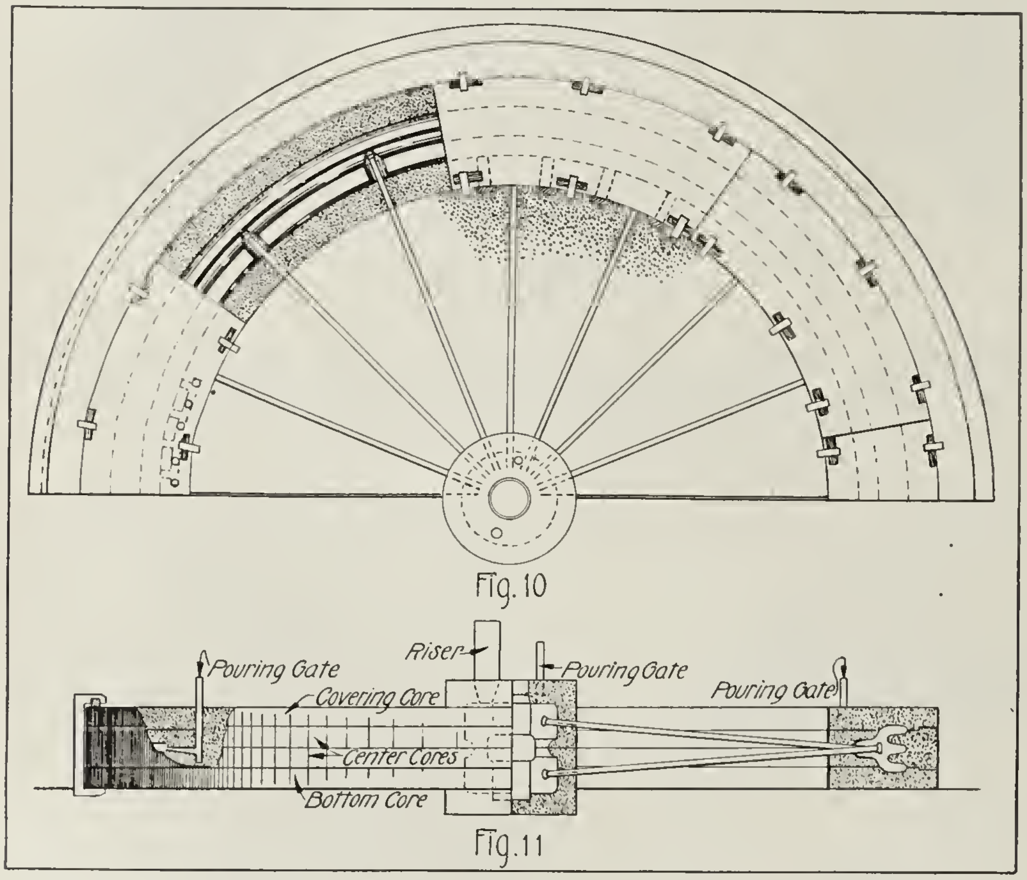


FIG. 10—PLAN OF MOLD FOR STEEL SPOKE SHEAVE WHEEL
FIG. 11—SECTIONAL VIEW OF MOLD SHOWING DETAILS OF HUB AND RIM CORES

Figs. 10 and 11 show the mold of a common type of sheave wheel having steel spokes, 1 inch in diameter. It will be noted that the hub is formed by cores in the manner employed in molding the wheels previously mentioned. The cores for the rim are in halves which form the center of the inside face of the rim, a core which forms the outer face of the rim and top and bottom cores which lie above and below the others. The metal is poured into the mold through gates in the top, or cover cores, or through gates leading into the center portion of the rim at its inside face. The former method is preferred, but in either case the metal should be poured simultaneously into three or four gates, evenly spaced on the rim. A riser should be provided to feed the hub.

In casting the two types of wheels and sheaves, many foundrymen experience trouble due to the breaking of the spokes. In the case of 7 and 8-foot wheels having light rims similar to that of the wheel in Fig. 6, the breaks usually occur near the hub. Investigation of this difficulty shows that if the hub is poured on the same side as the rim, and if hot metal is poured on or near the steel spokes, that the strength of the spoke is impaired. With hot iron dropping into the hub alongside of the spokes which previously have been subjected to the high temperature of the molten iron in the rim, and with the bottom gate retarding the shrinkage, the stress upon each of the few spokes near the pouring gate is in excess of that on any of the other spokes; consequently, one or more of them will not be strong enough to withstand the tension of contraction caused by the cooling of the hub.

To insure success in casting metal around the spokes, one or more gates, large enough to allow the hub to fill quickly, should be provided. If these precautions are taken, the spokes will not be burned, but will retain their original strength. Moreover, a steel that is too high in carbon should not be used, and under no circumstances should the hub be poured before the rim has had ample time to set. Sand should be rammed against the inner cores of the rim and against the outer cores of the hub, but the center section of each spoke should be left exposed as much as possible.

Figuring the Cost of the Cupola Heat

By *W. J. Keep*

Question:—Kindly tell us the exact cost of iron as it is tapped from the cupola. Our recent heat, as shown by our daily report, totaled 7,100 pounds, which consisted of 1,200 pounds of coke at $10.80 per ton; 2,100 pounds of pig iron at $26.50 per ton; 700 tons of pig iron at $19.50 per ton; pig bed returned to the cupola, 750 pounds; gates charged, 1,200 pounds; machinery scrap, 900 pounds, at $12 per ton; stove plate, 950 pounds at $9 per ton; 500 pounds of shot, and 60 pounds of limestone, at $1.25 per ton. The cost of cupola labor was $8.25 for the cast.

Answer:—With cupola labor $8.25 for the cast with 1,200 pounds of coke at $10.80 per ton, the cost of the coke for the heat was $6.48 and the labor and coke for the charge of 7,100 pounds represented a cost of 0.21 cent per pound for the 7,100 pounds. The 2,100 pounds of pig iron cost $27.33; 700 pounds of pig iron, $6.72; 900 pounds of machinery scrap, $5.40; 950 pounds of stove plate, $4.28, to which must be added the cost of the 750 pounds of remelt pig bed, 1,200 pounds of gates and 500 pounds of shot, representing a total of 2,450 pounds to be charged at the cost of the mixture, representing an expense of $23.32. Against 2,450 pounds must be charged 0.21 cent per pound for labor and coke from the previous day, amounting to $5.14. The 60 pounds of limestone at $1.25 per ton represent a cost of 4 cents, making a total of $87.46 for the 7,100 pounds of iron melted, or a cost per pound of 0.0123 which is equal to $24.64 per ton. Taking into consideration incidentals, such as lining of cupola, etc., the cost would be approximately $25 per ton.

Belt Slings for Cores

A New England foundryman uses old leather belts as slings for carrying heavy cores around the shop. These slings, which are about 5 feet long, are suspended from the crane hook in the same manner as ordinary chain slings. They are particularly suited for handling round or barrel-shaped cores 6 inches or more in diameter. The leather grips the core firmly and at the same time does not injure or scratch it in any way. Slings of this type cost practically nothing, since old belts that are useless for power transmission may be employed. Such belts are even preferred to new ones on account of their superior flexibility. Belts from 3 to 4 inches wide are considered most satisfactory.

Protective Coatings: Lacquers---I

By E P Later

AMONG the many materials used in the art of finishing and protecting metals, few are of greater importance or deserve more careful study than the lacquers and japans or enamels. It is one thing to produce, by plating or coloring processes, a finish which is beautiful and pleasing to the eye, but it is an entirely different problem to preserve its beauty for any considerable period of time, since almost without exception such finishes are comparatively unstable in the air and soon fade or tarnish unless they are protected by some kind of a coating which will exclude air and moisture.

The substance which is commonly known as lacquer is widely used for this purpose, in the form of a clear, slightly yellowish liquid that, beyond giving a rather high lustre to the surface, does not add to or detract very much from the appearance of the finish. By the addition of dyes, however, lacquers can be made to protect not only the finish from tarnishing, but will enhance its beauty greatly and thus serve a double purpose.

Knowledge of Composition and Application

To obtain the best results, however, in this as well as in any other line, requires at least some knowledge of the composition and proper methods of application of these materials. Many a plater has wondered why his special finishes did not hold up and has sought various explanations for this, without suspecting that a poor lacquer, or one which is improperly mixed or applied, is the cause of all the trouble.

Chinese and Japanese lacquers, which produce unusually beautiful finishes, have been used for a great many years and are obtained from certain native trees; in reality they are more like oil varnishes. The ordinary lacquer used in metal finishing is largely a manufactured article and the history of the development of these materials is interesting, recounting as it does the record of a tremendous amount of experiment and research, but space does not permit of a more detailed reference to it. It may be said, however, that the discovery of the action of nitric acid on paper and other forms of cellulose, resulting in the production of compounds known as nitro-celluloses, by the German chemist Schönbein in 1845 was the first step in this evolution. Many years of work were required, however, to develop suitable solvents and otherwise put these compounds in proper shape for use, so the appearance of the modern type of lacquer such as we know it today, dates from about 1882, when John Stevens took out a series of patents for solvents of pyroxylin, certain classes of nitro-cellulose; among these solvents was amyl acetate. Many other solvents have been patented and some of them find a more or less extended use, but amyl acetate, or *banana oil,* continues to hold an important place in the list of such substances. The manufacture of pyroxylin lacquers was started at Springfield, N. J., in 1886, and when the question of the infringement of certain patents developed it resulted in the formation of a company for the manufacture of these products.

Referring to the lacquers used today, these are divided into three general classes, based on their composition: First, we have those containing only some gum in a volatile solvent; second, those which are a solution of pyroxylin in a suitable solvent, and third, lacquers containing both gum and pyroxylin.

The first class, therefore, practically belongs in the list of materials known as spirit varnishes. Resins in solution in amyl acetate or some similar solvent, but free from turpentine or pyroxylin, are known as resin lacquers. The resins usually employed are shellac, copal, sandarac and mastic, given in the order of their relative importance. Damar, amber and the hard copals are soluble only with difficulty in amyl acetate and amyl alcohol, fusel oil, although the solubility is increased by fusing or otherwise treating them. Certain resins, such as elemi and myrrh, which are too soft to be used alone give good results when mixed with sandarac, for example, and some of the softer copals, appearing to increase the elasticity and lessen the brittleness. Some members of the class of substances known as balsams, such as Peru, storax, tolu, etc., are still softer and are also used with other resins to produce a tough film.

Origin of Resins and Gums

It may be interesting to consider briefly the origin of some of the more widely used resins and gums. Gum shellac is as exudation which appears on several eastern trees, following the sting of certain insects which lay their eggs in and are themselves enveloped by the sticky mass. This is collected and refined by melting and straining through cloth, afterward pouring it over a cold metallic or other surface. If desired, it may be bleached later and made the basis of a white varnish. Shellac is more or less soluble in several liquids, but is perhaps most widely used in alcoholic solution.

Copal is a term which is rather loosely used to designate a number of resins, both hard and soft, which are obtained from some of the eastern and tropical countries. The soft copals, which are of importance in lacquer manufacture, are the products of living trees, but the hard varieties are of fossil or recent fossil origin, that is, they were formed and perhaps have been buried in the earth for many hundreds of years. All are of a vitreous appearance, transparent and of a yellow or reddish color.

On the whole, copal is the cheapest of the resins used in lacquer making and it finds extensive use on the cheaper classes of work, such as tags, fruit cans, and so on, generally being mixed with aniline dyes, to produce any desired color.

Sandarac is as hard as kauri copal and in some ways possesses even more desirable qualities. It exudes from the bark of a tree growing in Africa and is readily soluble in the common alcohols, wood, grain and amyl, less so in amyl acetate and only slightly soluble in benzol and benzine, a fact which is used to advantage in making lacquers to produce a frosted effect on glass. By dissolving a resin in a low boiling point solvent, that is, one which evaporates quickly, and adding to this solution a non-solvent which evaporates but slowly, it is clear that when such a lacquer is applied to glass or a metallic surface the more volatile liquid will pass off first, leaving the one which is not so volatile. The resin, not being soluble in this, is slowly precipitated out. Copal, mastic and damar have been found unsatisfactory for this purpose inasmuch as they do not adhere very strongly, but sandarac seems to do very well, producing a hard, opaque film closely resembling ground glass.

Mastic is also an exudation from a tree native to the east, but does not find a very wide use in lacquers, although it is employed to some extent in bronzing liquids.

Applying Resin Lacquers

As a class, resin lacquers are applied by brushing, owing to the large amount of total solids in solution; these range from one to four pounds per gallon. A good resin lacquer will stand brushing out without leaving any marks, will dry without artificial heat and will exhibit a high gloss. One objection to their use is that all of these resins contain varying amounts of certain organic acids which are liable to attack metallic surfaces, such as copper, and cause blackening, unless care is taken to reduce the acidity as much as possible. In general, they can be mixed in all proportions with pyroxylin solutions, using properly selected solvents.

Shellac produces a useful and widely employed lacquer which gives good satisfaction for many purposes and a large variety of parts is finished with it. The so-called French bedstead lacquers are made from highly refined and bleached shellac in grain alcohol, a sufficient amount of various vegetable dyes being added to produce the desired color, usually some shade of gold. The lacquer is brushed onto the cold part, which is then heated in an oven to a temperature of approximately 80 degrees Cent. for about 30 minutes, the result being a hard and brilliant finish.

The fact that shellac possesses a high co-efficient of expansion is made use of in burning-off lacquers, which usually contain wood alcohol, benzine, and a small amount of fusel oil. The parts are immersed in the lacquer or the latter is applied with a brush, then touched with a flame and the solvent is allowed to burn off, whereby enough heat is generated to melt or soften the shellac. Upon cooling, this contracts and forms a strong, hard film. Somewhat along these lines is the practice of buffing and polishing a shellac lacquer until the coating softens and partially fuses under the heat.

Properties of Pyroxylin Lacquers

Before the pyroxylin lacquers can be discussed it will be necessary to consider the process of manufacture and properties of this material. The substance known as cellulose constitutes the structural basis of a plant, the fibre, etc., but by far the larger part of the substances used for nitrating and application along industrial lines consists of cotton in some form or other, which in turn contains about 90 per cent of cellulose, when in the raw state. Ordinary cotton waste from the various mills is the form in which it is most widely used at present for this purpose. In the manufacture of explosives and the higher nitrated products, a little different type of material is employed, while a special kind of paper finds a wide use.

After being thoroughly cleaned, freed from grease and foreign substances and subjected to certain treatments, which are necessary or desirable, the waste is immersed in a mixture of nitric and sulphuric acids. There are several different methods of doing this, but the result in all cases is the same; a series of chemical reactions take place wherein the cellulose acquires anywhere from two to six molecules of a nitrogen and oxygen compound, thereby markedly altering its character in some respects. The length of time and the temperature of the mixture depend on the product desired. Long nitration with strong acid, at rather low temperatures, gives the higher nitrated materials, guncotton, for example, while proper regulation of the process gives substances containing less nitro groups and known as pyroxylin, used in making lacquers, collodion, celluloid and the like.

When the action has proceeded as long as desired, the cotton is taken out of the acid and the excess of the latter is removed by centrifuging, following which it is thoroughly washed in cold water. This in turn is displaced by some solvent, denatured ethyl alcohol or propyl alcohol, or the mass is subjected to great pressure in order to drive out the remaining water.

It may be stated that the finest and whitest lacquers, used on silverware, are produced by nitrating tissue paper, but the process, in the main, is as described.

It is impossible to go into the question of pyroxylin solvents very deeply here, but it may be remarked that pyroxylin is soluble in a number of liquids, some of which are comparatively expensive, especially since the war began; consequently, the selection of the proper one for the purpose in hand and its dilution to the greatest permissible extent is an important problem. To produce the proper adjustment of the constituents of a lacquer or thinner, requires much skill and experience. Thus, amyl acetate is an excellent solvent for pyroxylin, but just now is scarce and costly; therefore, benzine, which is comparatively cheap, but a non-solvent, is added in as great a proportion as permissible, stopping just short of actual precipitation of the pyroxylin from the solution. Other liquids are added for various reasons, but the amount of high-boiling and low-boiling liquids must be so arranged that the film will dry at the proper rate to make it smooth and free from wrinkles.

Pyroxylin Lacquers

A pyroxylin lacquer is nothing more than a solution of this substance, perhaps five or six ounces per gallon, in a suitable solvent and usually is shipped to the customer too heavy for use, requiring to be diluted with the thinner, which is of about the same composition as the solvent portion of the lacquer. From what has been said it can easily be seen that substituting one thinner for another or using a home-made variety is liable to result disastrously, and unless one has an intimate knowledge of the subject it should not be attempted.

Before using, the lacquer is thinned until it is of the proper consistency which, in the last analysis, depends on the film produced. Generally, the dilution is continued until the dried film iridesces or assumes rainbow tints, then a little unthinned lacquer is added to the thinned portion and the whole is ready for use. It may be that the film produced before this point is reached is deficient in strength or too thin for the purpose desired, so this quality may be made the criterion and the addition of thinner stopped when the film fails to meet certain tests. It is economy, of course, to use as much thinner as possible, consistent with good work, since it is cheaper than the lacquer and there is the further consideration that a very thin coat of lacquer is less liable to give a white metal, such as silver or nickel, a yellow tinge, so the lacquer is thinned to the last degree. Sometimes a very small amount of resin, shellac for example, is added to decrease the liability to iridesce, thereby permitting thinner films.

These preparations find a large variety of uses in other lines as well as in metal finishing and are applied by brushing, dipping, or spraying, depending on the character of the work. After lacquering, the parts generally are placed in a warm room or drying cabinet and gently heated for a time to hasten thorough evaporation of the solvent and hardening of the film. For many purposes a colored lacquer is preferred to a clear, white one, to give a richer color to a metal. In such cases aniline dyes are dissolved in a suitable solvent such as wood alcohol, acetone, amyl acetate, etc., and added to the lacquer.

On the whole, pyroxylin lacquers give a thin, smooth and elastic film, which does not change the appearance of the metal surface very much, as a good lacquer is nearly invisible.

Pyroxylin-Resin Lacquers

The pyroxylin-resin lacquers possess superior qualities to either of the classes previously considered, and therefore permit of a much wider range of usefulness. This is only natural since by combining two or more materials the good qualities of each may be emphasized. Thus hardness and covering power may be increased without augmenting the flow, and so on. The combinations of pyroxylin and shellac are probably the most extensively used, although other resins and combinations of these also are employed. The composition of most lacquers cannot be very definitely stated since this depends on the nature of the work and the requirements of the finish. In a general way, a lacquer possessing almost any desired qualities can be produced by the proper selection of the solids, pyroxylin and resins, and their solvents.

These, as well as the straight resin lacquers, are applied by brushing or spraying and are used largely for the purpose of ornamentation, in distinction to the pure pyroxylin variety which is intended mostly for protection. Mixed with various colored pigments, they can be used for the production of an infinite variety of finishes such as weathered and antique effects, dull and high gloss blacks, etc.

Bronzing and Gilding Liquids

Bronzing and gilding liquids may be briefly mentioned, since some of these are made up on a pyroxylin base and contain a small amount of resin. When needed for use, a quantity of finely divided metal of the desired color is stirred into the liquid which is then applied, usually with a brush. They are used for gilding a large variety of ornamental work, picture frames, statuary and the like, and also for coating steam and water pipes, radiators, etc.

This article would hardly be complete without some reference to a certain class of lacquers and other materials known broadly by the term *phenol condensation products*, which have come on the market during the last few years. The reactions which take place when phenol, carbolic acid, and formic aldehyde are allowed to act on each other under the proper conditions result in the formation of various compounds which possess some unique qualities, and perhaps the best known of these is bakelite, named after its discoverer, Dr. Leo Baekeland. This may be obtained as a clear liquid permitting of application to metal and other parts in the same way as other finishing materials; when subjected to heat, the bakelite dries to a fairly hard film, which may be made still harder by the application of a higher degree of heat. The most interesting point about it, however, is that the solid material is stable toward acids, alkalis and other destructive agents; therefore, it would seem that it could be used to good advantage in cases where an exceptionally resistant finish is required.

The ordinary resin-and-pyroxylin lacquers have many good points in their favor and it would be very hard to get along without them, but they have their weaknesses also, so it is highly probable that they will be replaced for certain purposes, at least to a limited extent, by some of the newer finishing media which are of entirely different composition and properties.

The co-partnership of Fuller & Smith, Cleveland, advertising writers and counsellors, has been changed to an incorporated company without change in the firm name. The incorporators are Harry Dwight Smith, president; Fred R. Fuller, vice president and treasurer; Norman Craig, vice president; A. Judson, secretary; P. W. Murphy, secretary to the president; C. L. Madden and C. E. Horton. Except in minor details, the organization and method of handling the business will remain the same.

Foundry Equipment Co. Extends Plant

The plant of the Foundry Equipment Co., Cleveland, has been removed from 2102-2118 Abbey avenue to 1831 Columbus road and Girard avenue. Two large, well-lighted and well-ventilated factory buildings, formerly occupied by the U. S. Bronze Co. and the Standard Brass Co., have been purchased, which insure ample manufacturing and warehouse facilities. The company manufactures a complete line of foundry equipment, including core and mold ovens, core and mold cars, brass and aluminum furnaces, hand squeezers, water tumblers, sprue cutters, oil burners, crucible lifters, etc. A foundry engineering department also is maintained, which specializes in the design of foundries and other industrial plants. F. A. Coleman, formerly president and J. D. Smith Foundry Supply Co., and the Coleman Foundry Equipment Co., is general manager of the Foundry Equipment Co. and is in direct charge of the design of the complete line of equipment which it manufactures.

Westinghouse Company Will Build

The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., recently has purchased a plot of ground at Essington, near Philadelphia, which embraces about 500 acres with a frontage of approximately one mile on the Delaware river. Additional transportation facilities will be afforded by tracks from the Pennsylvania and Philadelphia & Reading railroads. This new center will be devoted to the production of large apparatus, the first group of buildings being for power machinery, such as steam turbines, condensers and reduction gears. The initial development will cost approximately $6,000,000 and the buildings will occupy about one-fifth of the area of the entire plot. This group will consist of the following structures: Two large machine shops, erecting shop for heavy machinery, forge shop, pattern shop and pattern storage and power house.

The Gulick-Henderson Co., engineer, chemist, assayer and metallurgist, has consolidated its general office in New York City, located at 30 Church street and 120 Broadway, respectively, and has removed them to suite 1932-1939, 13-21 Park Row.

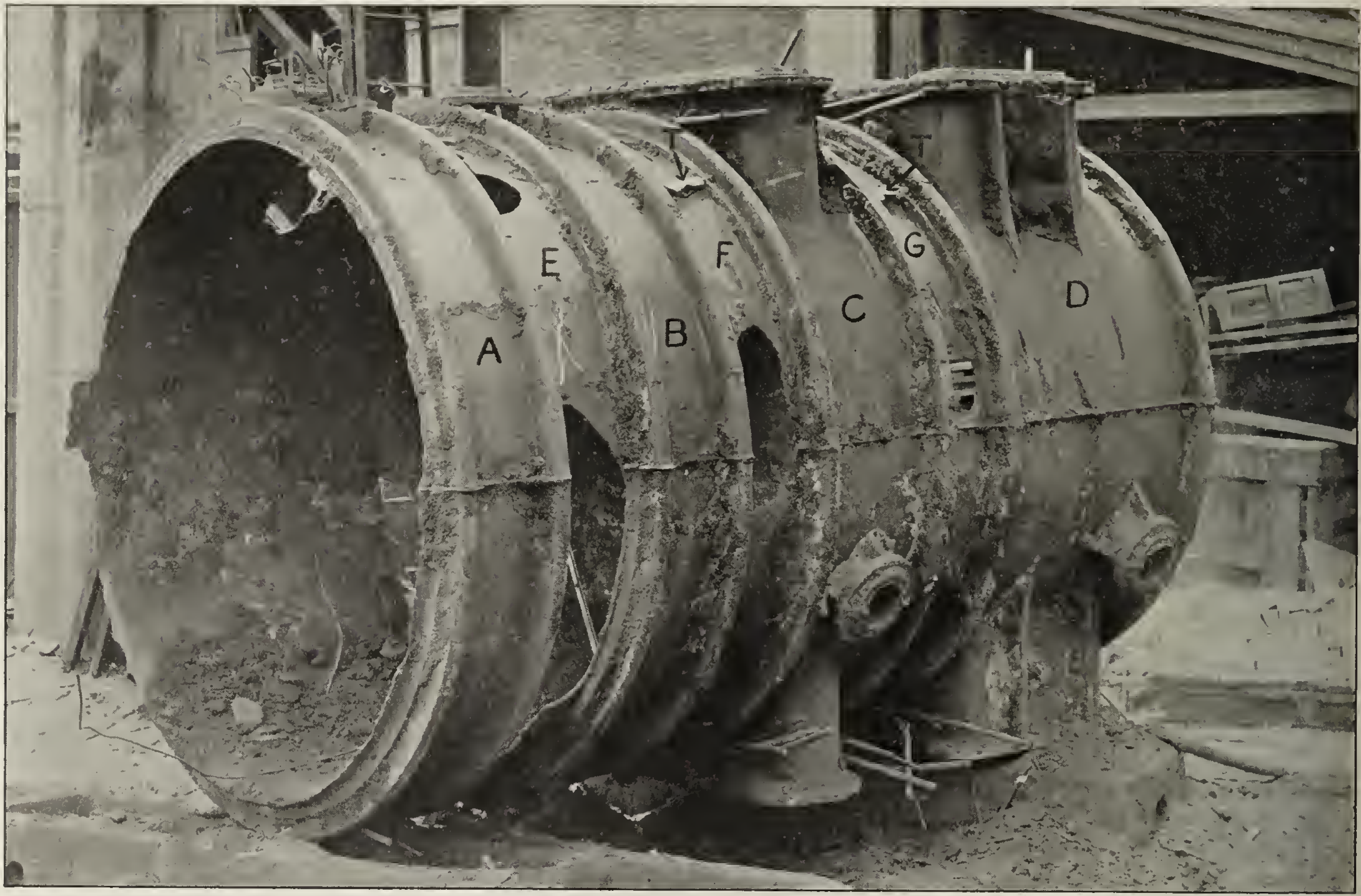


FIG. 1—AMMONIA STILL SECTIONS IN THE CLEANING YARD READY TO BE BROKEN APART

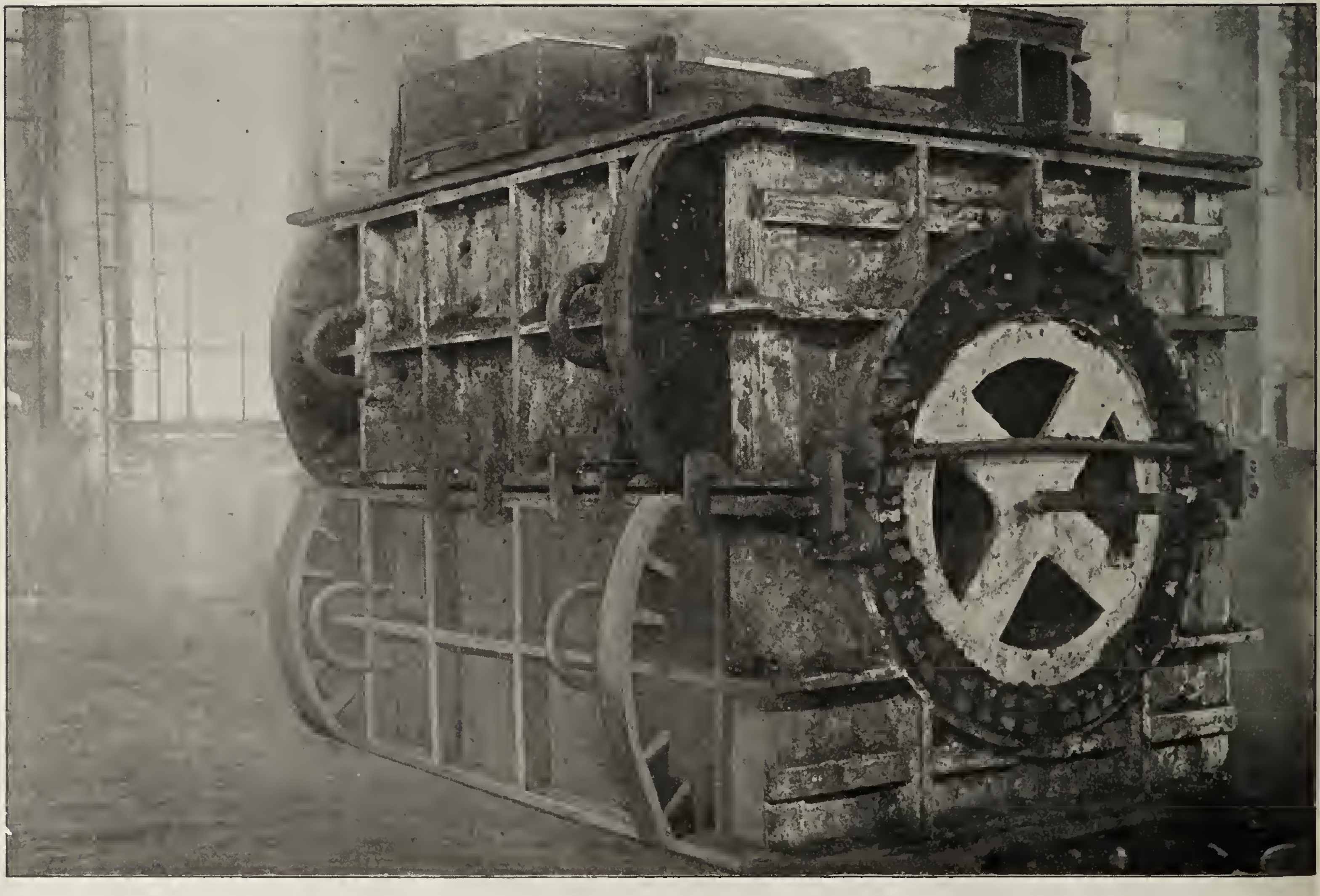


FIG. 2—THE MOLD ASSEMBLED READY FOR POURING

How Heavy Ammonia Stills Are Molded

A Novel Method of Molding Enabled the Hooven-Owens-Rentschler Co. to Double Production on a Limited Floor Area

IN TIMES like the present, when every inch of shop floor space is constantly in demand, foundrymen are encouraged to exercise their ingenuity in devising new methods of obtaining a maximum tonnage with minimum facilities. The superintendent who realizes 50 per cent in excess of the production usually expected from his shop, without waiting to make extensive additions to his buildings or equipment, is valued highly when business is moving forward rapidly. If he can achieve this increased production without materially adding to his costs, the pinnacle of efficiency is approached.

As an example of what can be done in handling an excessive tonnage of heavy castings with ordinary apparatus, the methods pursued in the shop of the Hooven-Owens-Rentschler Co., Hamilton, O., are worthy of study. This plant is operated under the direction of James A. Murphy, foundry superintendent. The molding floor is 70 x 400 feet and the melting equipment includes three cupolas with a combined capacity of 51 tons per hour. With these facilities a great variety of heavy castings are produced, including massive bed plates for rolling mill engines, large flywheels, heavy cylinders, etc.

Recently this foundry was called upon to make a large number of cast iron sections for ammonia stills for installation in connection with by-product coke oven plants. These sections are nothing more than flanged rings 70½ inches in inside diameter, and vary from 16 to 42 inches in length between flanges. Some of the larger sections are provided with wide-mouthed flanged outlet connections which complicate the casting.

How the Production was Doubled

Under ordinary circumstances these rings or sections, which vary in weight from 1¼ to 3 tons, would be molded horizontally on the floor in separate flasks of various sizes. But in order to turn out any considerable number of rings rapidly by this method, a large floor space would be necessary, together with extensive flask equipment. In handling this work in the Hooven-Owens-Rentschler foundry, Mr. Murphy was confronted with the problem of obtaining at least a dozen castings a week without interfering with the large amount of other work going through the shop. It was necessary, therefore, to devise some method of materially curtailing the floor area occupied by the job. Also, it was equally necessary to speed the production up to the limit in order to get the work out of the way as quickly as possible and make room for subsequent jobs.

The problem was solved by molding and casting two of the larger and two of the smaller sections as one piece in a heavy cast iron flask, using a single pattern. This was readily accomplished by placing the sections together so that they formed a large pipe or cylinder. In order to facilitate the separation of the individual castings, the sections were connected by thin rings or fins of metal which were easily broken out in the cleaning yard.

One of the complete castings made by this method is shown in Fig. 1. The ammonia still sections are shown at *A*, *B*, *C*, and *D* in this illustration, separated by the connecting rings *E*, *F* and *G*. Portions of these rings already have been knocked out in order to free the castings from one another.

The rough castings weigh 7½ tons. The two smaller sections, shown at the left in Fig. 1, which are 16 inches in length, weigh 2,500 pounds apiece. The middle section, which is 23 inches in length, weighs 4,500 pounds. The section at the extreme right end of the casting, which is 42 inches in length, weighs 6,500 pounds. Each section is 70½ inches in diameter inside. The flanges are about 2¼ inches wide and one-inch thick.

The pattern, which is wood, is split axially. The two halves are molded in the cope and drag, respectively, just as if an ordinary small floor job were being handled. The parting line between the two halves of the mold is shown very clearly in Fig. 1.

Using this method of molding, four men turn out three sets of castings per

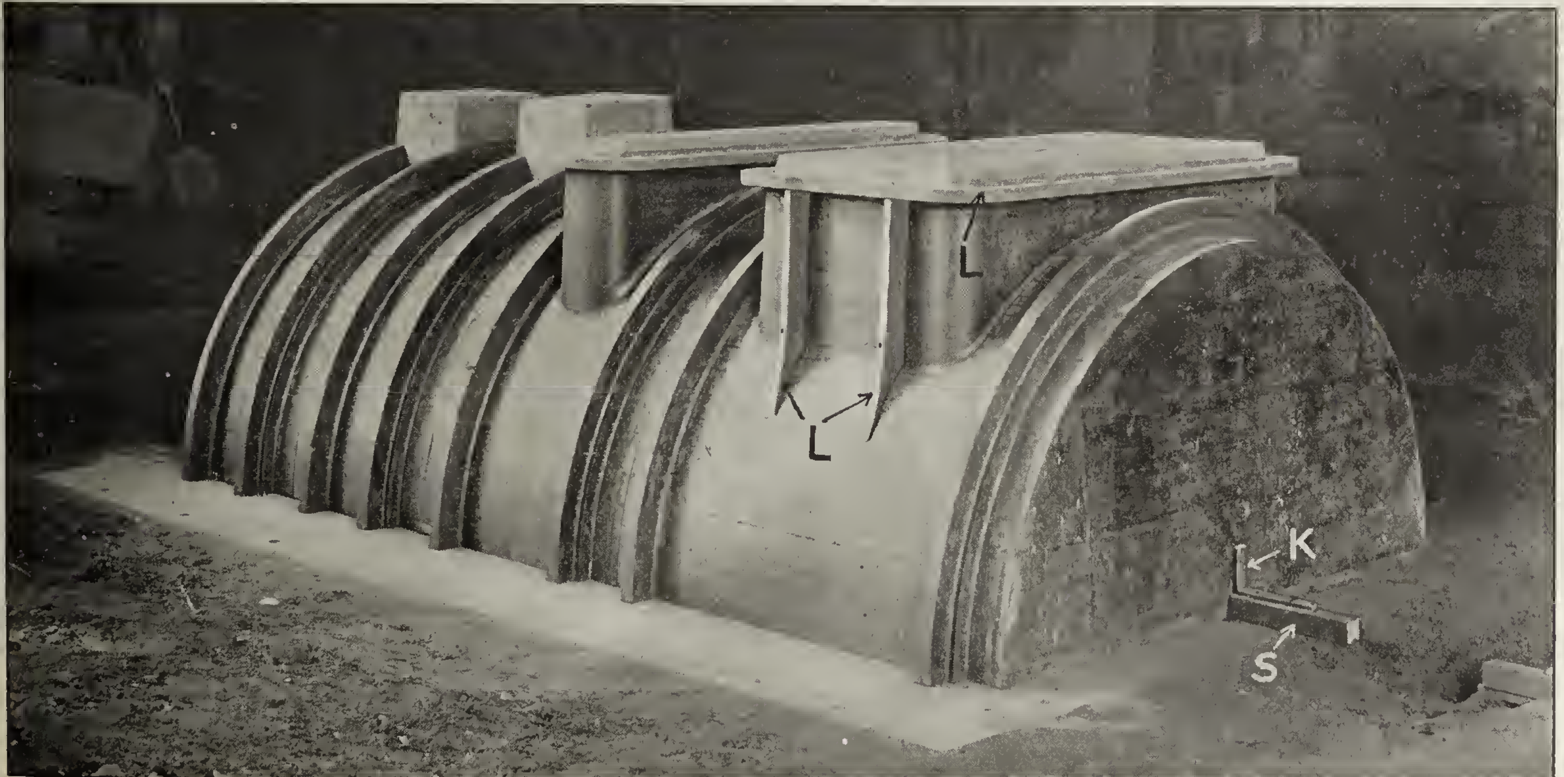


FIG. 3—DRAG HALF OF PATTERN ON FLOOR PLATE

week. The total production, therefore, is six large and six small still sections. In order to attain this production, the four men who work on the job put up a complete flask in two days. Two men work on the cope and the other two on the drag. Another man is employed who spends a day in finishing and closing each mold. It is evident that this method of molding results in at least double the production which could be obtained by molding the sections separately on the floor. The complete mold with the core in place weighs 24 tons.

The method of molding the drag is illustrated clearly in Figs. 3 and 5. The former shows the pattern in its proper place on the bottom-board, and the latter shows the drag after it has been rolled over. In Fig. 5, the cores forming the flanged outlets have been set. The drag, which is of heavy ribbed cast iron construction, is 12 feet long, 8 feet wide and 5 feet in height. A 2-inch square steel web is cast in each end of the drag, across the top of the arch, in order to strengthen it at its weakest points. The bases of the arch are tied together by a 1½-inch wrought iron rod which is provided with a suitable tension adjustment nut.

As shown in Fig. 3, the pattern and flask rest on a heavy cast iron plate set in the floor. This plate, which is 12 feet long and 9 feet wide, serves the purpose of a bottom-board. The upper or exposed surface is planed true. The pattern fits securely over a 2-inch square steel spline which extends the full length of the plate. One end of this spline is shown at *S*, Fig. 3. In order that the pattern may be accurately centered in the flask, a steel bracket, *K*, is bolted to one end of the spline. The pattern is shoved up snugly against this bracket, and is thus centered automatically. The flask pins fit in machined holes in the floor plate.

It is not feasible to jar-ram the mold on account of the various flanges under which the sand must be tucked properly. These flanges and ribs, *L*, Fig. 3, of course are loose and are removed from the mold either before the flask is rolled-over or after the main pattern is drawn.

The mold is rammed entirely by hand. The sand, which is furnished by the Hamilton Molding Sand Co., Hamilton, O., is said to be particularly adapted to heavy gray iron work. The mold is filled with old sand and is faced with a mixture consisting of 50 per cent old and 50 per cent new sand. No special facings are employed.

The general arrangement of the cope portion of the mold is shown in Fig. 6. This illustration shows clearly the heavy rockers cast on the sides of the cope to facilitate rolling it over with the traveling crane. The large eyebolts in which the crane hooks are fastened also are plainly visible. The cope is 12 feet long, 8 feet wide and 5 feet high. Its general construction is similar to that of the drag. The cope is molded over a half pattern, similar to that used for the drag. On account of the flanged outlets on the larger still sections, it is not possible to fit the cope with bars to hold the sand in the ordinary manner. Instead, a heavy cast iron grid, *R*, Fig. 6, is bolted to the top of the cope. The bars of this grid are provided with webs which extend down into the sand for about 2½ inches, thus staying the mold. The grid, of course, is not fastened to the cope until after most of the sand is thoroughly rammed in place. Fig. 6 shows the pouring basin on the top of the cope. This basin, which is constructed of dry sand, connects with six sprues arranged in two groups. The sprues are about 2 inches square and are so placed that they feed two set-gates. The location of the gates is shown clearly at *T*, Fig. 1. It will be observed that one of the smaller still sections, on the extreme end of the casting, is fed entirely through the connecting ring. The gates are made of lead so that they can be readily bent to fit the pattern.

The cope, which is rolled over by the

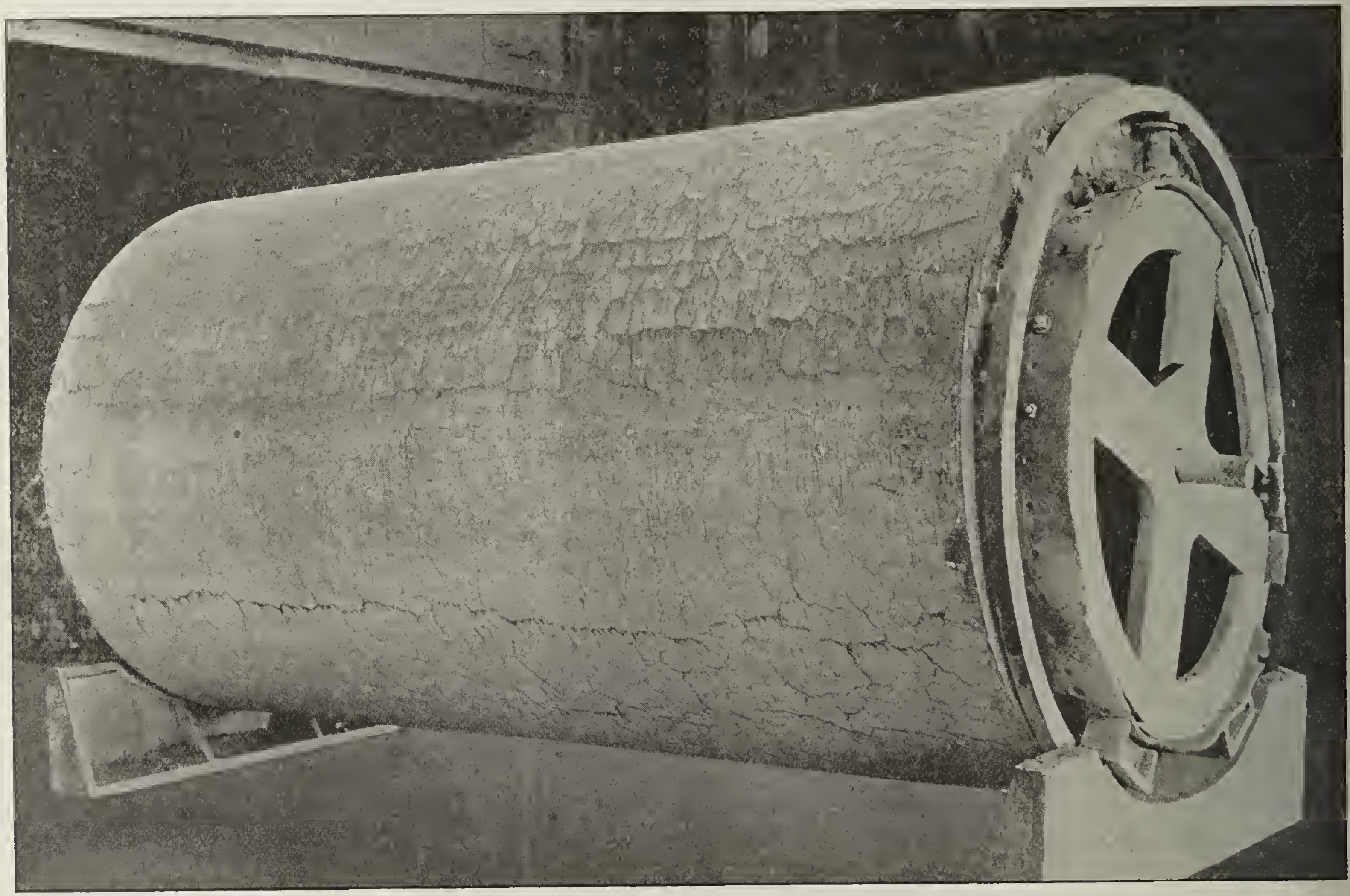


FIG. 4—CORE FINISHED AND BAKED READY TO BE INSERTED IN THE MOLD

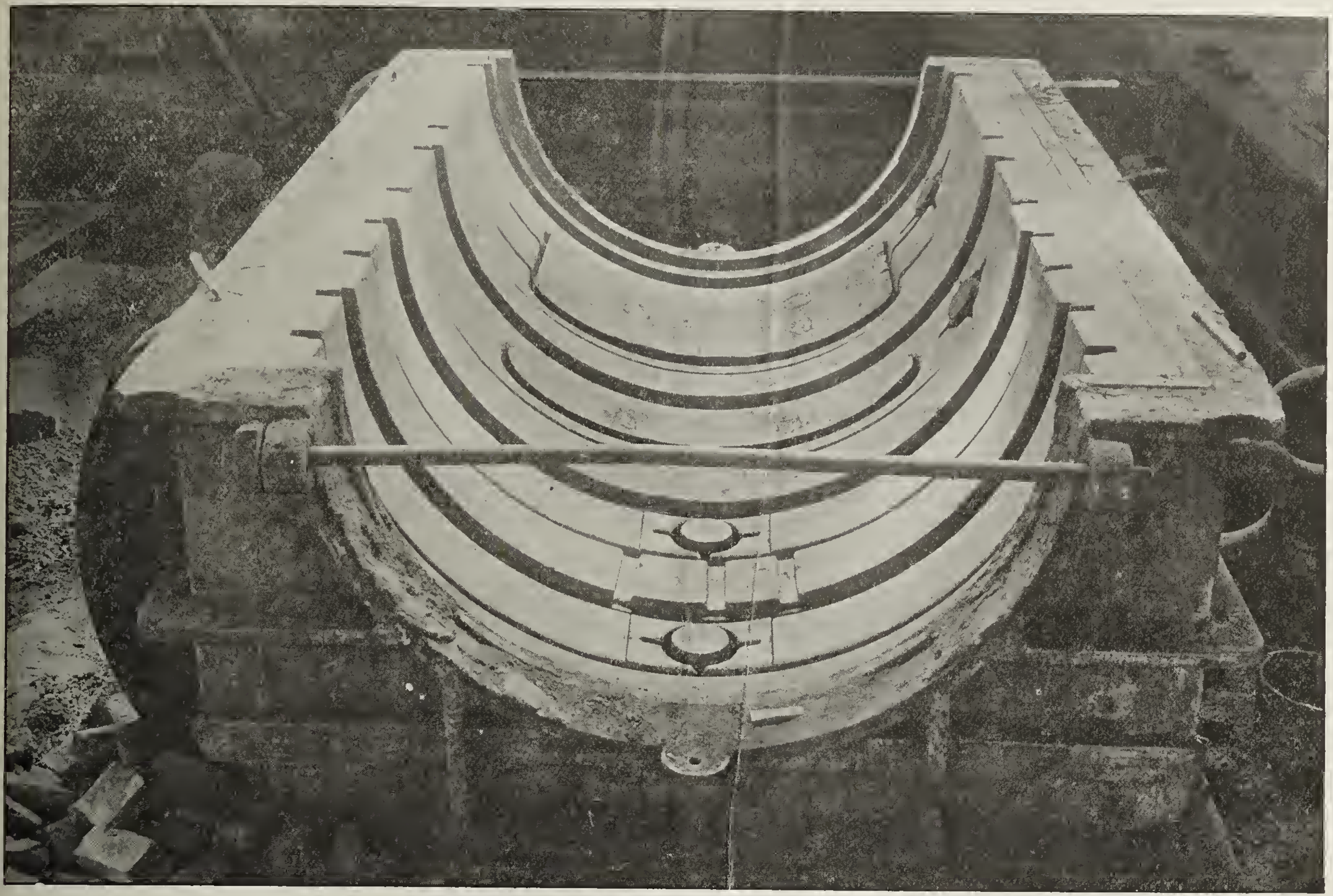


FIG. 5—DRAG MOLD ROLLED OVER AND FINISHED WITH OUTLET PASSAGE CORES SET

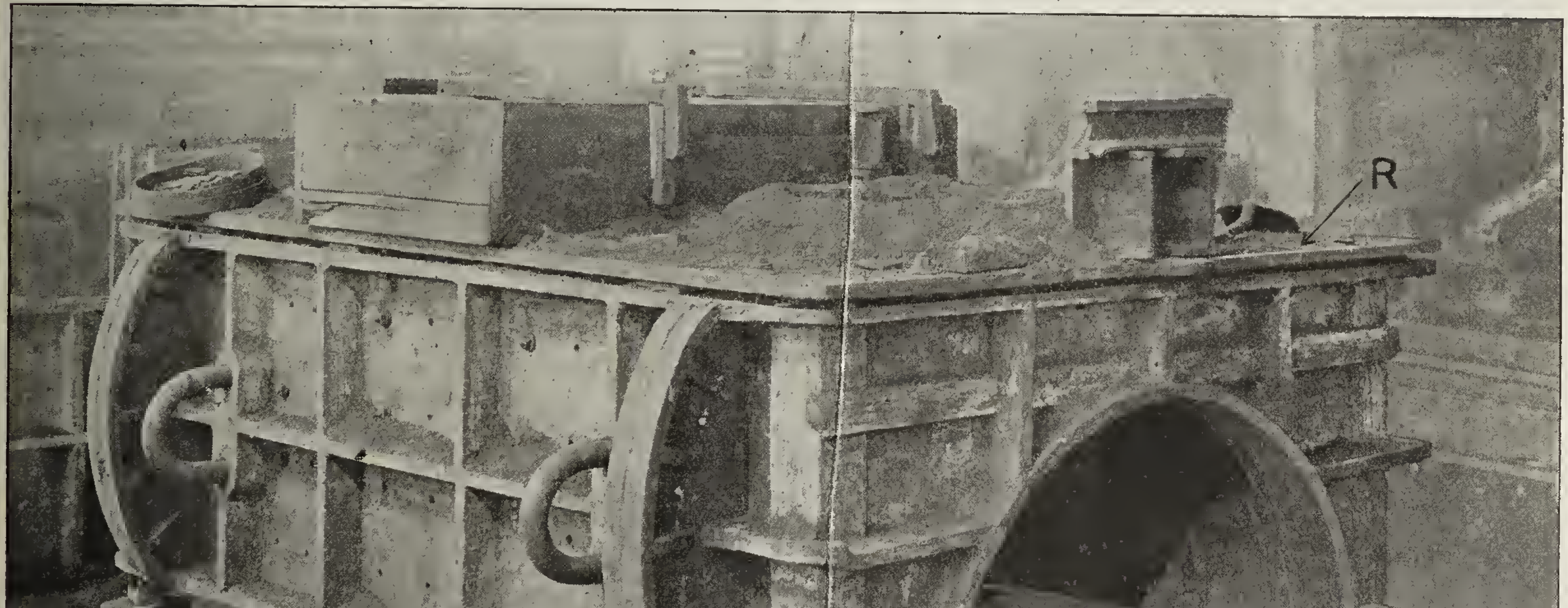


FIG. 6—COPE MOLD ARRANGED FOR SKIN-DRYING WITH CHARCOAL

crane, is set up on blocks for drying with a charcoal fire. Fig. 6 shows the arrangements for drying the cope, which are very simple. The casting is provided with two risers placed at the ends. They are utilized simply for flow-off purposes, there being no special amount of shrinkage to be taken care of.

How the Core is Made

The interior of the casting is formed by a large cylindrical core, Fig. 4. This core, which is 70½ inches in diameter and 10½ feet in length, is made by two men in 8½ hours. The arbor consists simply of four cast iron spiders covered with boiler plate, forming a, cylinder about 5 feet in diameter. In order to vent the core properly, the boiler plate covering of the arbor or barrel is pierced with a large number of ½-inch holes.

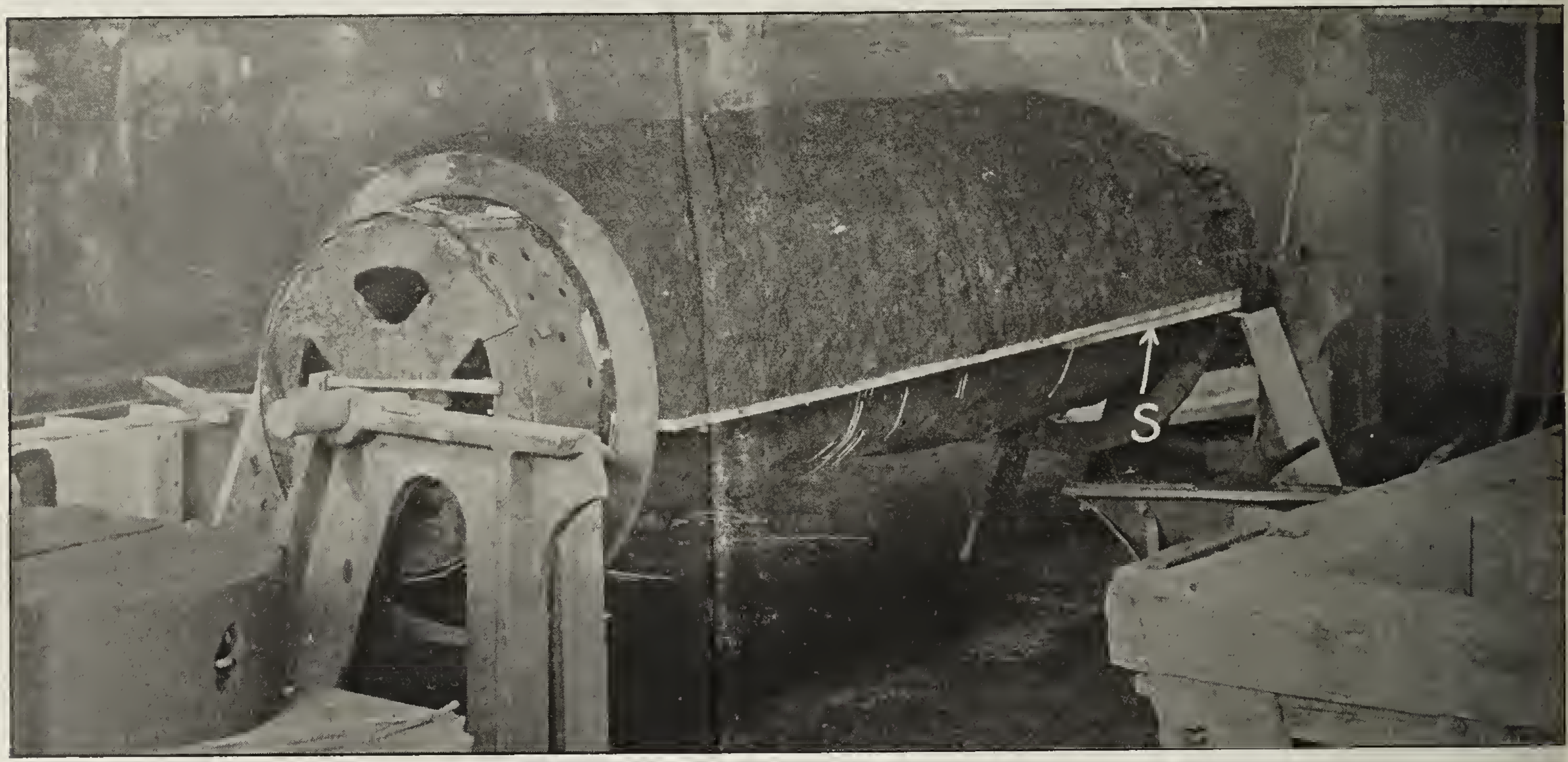


FIG. 7—HALF OF THE BARREL CORE IS SWEPT UP AT ONE TIME

The arbor is supported between standards as shown in Fig. 7. This illustration shows a corliss engine core that is similar to the ammonia still core. Stop-off boards, *S*, are provided and half the surface of the core is covered with sand. After the sand is properly tucked in place it is struck-off to a true semi-circle by means of a suitable sweep. The core is then placed in the oven and baked. After it is removed it is rotated one-half a revolution and the remainder of the arbor is covered with sand. After this sand has been properly struck-off, the core is placed in the oven a second time for its final baking. This double baking is necessary because the green sand will not adhere to the arbor when the care is rolled over. As shown in Fig. 4, the arbor is set eccentrically in the core, the sand being 3 inches in thickness on the bottom and 8 inches on the top. This is done in order to make it certain that the hanging sand on the bottom will not fall off. Both ends of the core are protected by rings of fire brick which hold the sand in place. The large cast iron rings shown at the ends of the core in Fig. 4 are used to stop-off the sand properly when the core is being swept-up. Although this method of making large barrel cores may not be considered ideal, it has the advantage of simplicity and is economical of equipment.

The finished mold, ready to pour, is shown in Fig. 2. The metal is handled in an 8½-ton ladle, about 1,000 pounds of excess iron being provided. For melting this iron three cupolas, 54, 66 and 72 inches in diameter, respectively, have been provided. The 54-inch and 66-inch cupolas were built by the Whiting Foundry Equipment Co., Harvey, Ill. The 72-inch cupola was built by the Hooven-Owens-Rentschler Co. The mixture is so proportioned that the metal in the casting will contain approximately 1.65 per cent silicon, under 0.09 per cent sulphur, 0.55 to 0.60 per cent manganese and 0.60 per cent phosphorus. The actual mixtures of pig iron and scrap used to obtain these results vary according to market conditions and the grades of pig iron on hand.

Mixture Heavy in Pig Iron

In general, an effort is made to use a mixture heavy in pig iron and for this purpose a considerable proportion of No. 4 foundry iron is purchased and used in place of scrap. Some of this low grade pig iron contains only 0.66 per cent silicon with 0.116 per cent sulphur and 1.17 per cent phosphorus. A liberal proportion of steel scrap also is utilized to give the casting suitable characteristics.

In order to give a concrete idea of the mixture it may be stated that on June 13, each cupola charge consisted of 1,600 pounds of No. 2 northern foundry pig iron, 1,400 pounds of No. 4 northern pig iron, and 1,000 pounds of steel rail croppings.

Charging Fuel and Iron

The pig iron for these charges is piled on the charging floor in layers, each charge being separated from its neighbors by a heavy wire. This arrangement saves considerable time when the heat is being taken off. The steel scrap is weighed on a platform scale. The coke is not weighed, it being estimated that a fork full weighs 20 pounds. Some of the mixtures contain cast-iron borings which are packed in cartridges made from second - grade stove pipe. Each cartridge is about 6 inches in diameter and 2 feet long, weighing approximately 50 pounds. It is estimated that it costs $2 per ton to prepare the borings in this manner, and the melting loss is said to be practically negligible.

After the casting is taken out of the sand and transferred to the yard for cleaning, the core is removed by hydraulic methods, as previously described in *The Foundry*. The bricks which hold the ends of the core in place are first removed, after which the sand may be easily sluiced out from between the casting and the arbor with a 1½-inch hose stream. The water is supplied to the hose at a pressure of 250 pounds per square inch.

What Foundrymen Can Do to Prevent Hot Boxes

Careful Attention to Journal Bearings in the Foundry Will Result in a Reduced Number of Failures on the Road

By Russell R Clarke

IN RAILROAD parlance, a hot box is an expression for a hot-running journal. Railroad motive power difficulties are not a few. Of its constants of service-opposing circumstances none are more faithfully prevalent than this hot box. Neither are there many inviting greater seriousness of result. Greatest consequences are always germane to it, materializing in impaired journals, wheels, journal boxes, wedges and car underwork, all of which argue more or less persuasively to that greatest of all railroad evils, namely the railroad wreck. In the very premises, then, the elimination of the hot box is elementary to transportation efficiency and always a live issue in railroad circles. The hot box never invades a mystery of condition beyond explanation. It is always an effect following some definite cause or combination thereof. Otherwise, one of two conditions would be inevitable, either all bearings would run hot or none. That some do run hot derives its origin from a variety of causes either singly or conjunctively operative. Among these causes the following are mainly prominent: Improper composition of alloys, bad foundry practice in manipulation, inferior grade of material, a tight fitting of the bearing in either the wedge or on the journal, porosity of the lead-base lining metal, rough or abrased bearing surfaces, uneven surfaces in either the wedge or the back of the bearing, loose linings, excessive bearing surface, boring and lining the bearing out of line with its longitudinal center, poverty of lubricant, unequal distribution of load, inadequate protection against dust and grime and infrequent renewal of box packing. From this it will be seen that including the design of the bearing, its boring and its lining, at least 70 per cent of these evil-producing causes trace their sources to the foundry and challenge most justly its remedial considerations.

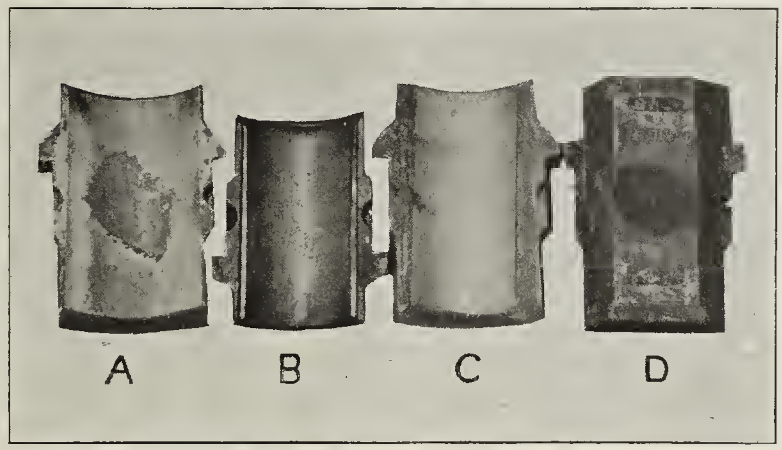


FIG. 1—FOUNDRY CAUSES OF HOT-RUNNING JOURNALS
A bare spot in tinning, causing loose lining; *B* porous lining metal; *C* lined out of line with longitudinal center; *D* swell in the back, shown by dark spot.

These considerations are the concern of this article. In those items of prevention beyond foundry jurisdiction to regulate, such as lubrication, renewal of packing, etc., we are at present interested only to the degree of remarking that their far-reaching influence invades no province of doubt, that they are the presumed and requisite assets of good service, that no bearing, regardless of its quality, can operate efficiently for any length of time unaided by them and that in dealing with an acute situation of hot boxes, their consideration as a probable source of difficulty is as logical as the spontaneous and proof-bereft conclusion of responsibility on the part of the foundry. To be concretely explicit, you can't blame the foundry for a hot box if a car inspector drops bits of oil-soaked waste on the ground and then pokes them into the journal box without thoroughly cleaning them. A common contention is that 90 per cent of the oil used in these boxes is wasted. If this be so, the foundry is not altogether without some mitigating evidence.

The modern railroad journal bearing is a composite affair consisting of a solid back of copper-base metal supplemented on its journal-facing side with a lining metal of lead base. It is commonly referred to in railroad parlance as a lead-lined bearing. Several common types of bearings are illustrated in Fig. 2.

The journal box wedge is a ferrous casting saddling the back of the bearing and occurring in the upper inside position of the box. The shape of the M. C. B. A. bearing back is of the trapezoid type. That of the wedge is similar, though slightly larger in dimensions to insure a crown-resting condition and thus obviate bending. If by any inconsistency in either bearing design or foundry practice the above conditions be reversed, the inevitable result is a pinching of the bearing sides in the wedge to which a breaking of the bearing or its tightening on the journal at the bearing's lower edges are invariably possible. This lower-edge-tightening effect seldom fails to produce a hot box and most logically so. The conditions are pre-eminently in favor of it. By it the area of pressure and bearing surface are reduced, localized and consequently intensified. To make matters worse, the wiping effect of the tight-fitting edge practically eliminates the lubricant, always supplied from the underside, from the bearing surfaces. Now it is the business of the foundrymen to see to it that these conditions do not arise which presupposes frequent checking of patterns and a rigid inspection of all bearings produced covering assurance of their true form and strict conformity to gage. Incidentally, the gages themselves should come in for frequent checking since by constant use some of them wear quite rapidly.

This same tightening of the bearing on the journal and its consequences follow the practice of lining the bearing on a mandrel-radius exactly equal to or less than that of the journal. A still further source identifies with the inconsistency of boring and lining the bearing out of line with its longitudinal center giving the bearing an out-of-line, twisting position on the journal and resulting in the same localized intensity of wear and pressure. This condition is shown at *C*, Fig. 1. In its position both in the wedge and on the journal, the bearing composite is figured to observe the crown bearing principle. Calculations on bearing surface, clearance, rocking space, etc., though always liberal, are never free from indiscriminate violation and foundries producing this class of work should keep steadily in mind that inefficiency in service may often result from the actual seriousness of an apparent insignificance. Still further important in this connection is the rectangular crown of the bearing back. A straight-edge test should always be made and show it to be a perfectly level surface. If swelled either uniformly or abruptly, as indicated at *D*, Fig. 1, it permits rocking and favors localized pressure intensity. The well-regulated shrinkage cavity in this crown back need not necessarily occasion the bearing's rejection, since there are types of bearings thus purposely cast to conserve metal. The unnatural cavity or depression, however, calls for best inspecting judgment, since a pattern-created and a molding-occasioned depression in a casting are entirely different propositions.

The composition of the copper-base should at least approximate that of a bearing metal. The wear of the journal collars on either end of the bearings in use today. Present-day tendency leans perceptibly to the junk bearing, an affair against which the author has a strengthening conviction. From a car of returned scrap, 50 badly crushed and mutilated bearings were indiscriminately selected by a man having no knowledge of the object of the procedure. The author went over these bearings and found 42 of them to be what he positively knew them to be, namely, junk-pot creations.

In dismissing this feature of the discussion, we might profitably remark that in their tentative specifications for non-ferrous locomotive equipment, the American Society for Testing Materials submitted two mixes for consideration in journal bearing connection. These mixes are referred to as bearing metal No. 3 and bearing metal No. 4, and read respectively as follows: Tin, 7 to 9 per cent; lead, 14 to 16 per cent; zinc, 3 per cent maximum, balance copper, and tin, 4 to 6 per cent; lead, 15 to 20 per cent; zinc 5 per cent maximum and balance copper. The author does not hesitate to record his opinion in favor of the No. 3 specification, which approximates the 78 copper, 7 tin, lead 15 alloy with zinc accommodations. No. 4 mixture bases practically on copper 72, tin 5, zinc 5, lead 18. The white metal lining is usually a combination of lead and antimony. As determined by Ralfe, the true alloy of these elements in combination shows lead 87 and antimony 13 per cent. An advance in the latter element beyond this figure shows particles of free antimony set in a groundmass of the eutectic. The nature of antimony is well known to be hard and extremely brittle, so that small particles in isolation near the bearing surface would open the possibility of their crushing and dislodging under the hard strains of service, resulting in a powdered metallic mixing with the lubricant and a mechanical porosity in the bearing surface, both of which are polar to good service conditions. Inclusion of a hard in a ground mass of softer material may be a good thing in some fields of bearing service, but in any so severe as the railroad journal bearing, we seriously question its wisdom. At any rate, as a hardening agent 13 per cent of antimony is ample for the occasion and yields a very satisfactory and, under normal market conditions, cheap lining metal.

With respect to the tentative specifications, as submitted by the American Society for Testing Materials, we call attention to the composition recommended for this metal, which reads as follows: Copper, 0.5 per cent maximum; tin, 4 to 6 per cent; zinc, 0.10 per cent maximum, antimony 9 to 11 per cent, and the balance, lead. This mix is practically based on lead, 85 per cent; tin, 5 per cent, and antimony, 10 per cent, which under normal market conditions must be admitted a comparatively expensive lining material in view of the great quantities requisite to railroad service demands. On its merits we possess no reliable data, but can see nothing in the premises to militate against its efficiency unless it be the zinc permitted. It goes without saying that in any lead-antimony bearing combination, reputable brands of virgin material are essential to high-class service. Especially is this true in the case of the antimony, where the margin of quality between a cheap and dearer grade is so wide. Cookson's antimony, of course, will give maximum results, though so sterling a brand cannot be said to be absolutely necessary to the demands of the occasion. However, when you slide too far down the scale and register in the zone of the cheap Hungarian brands, you can always look for more or less service dissatisfaction. The happy medium is the essential to creditable results at reasonable expense.

Manipulation of scrap along with new material is permissible, but presupposes enlightened common sense

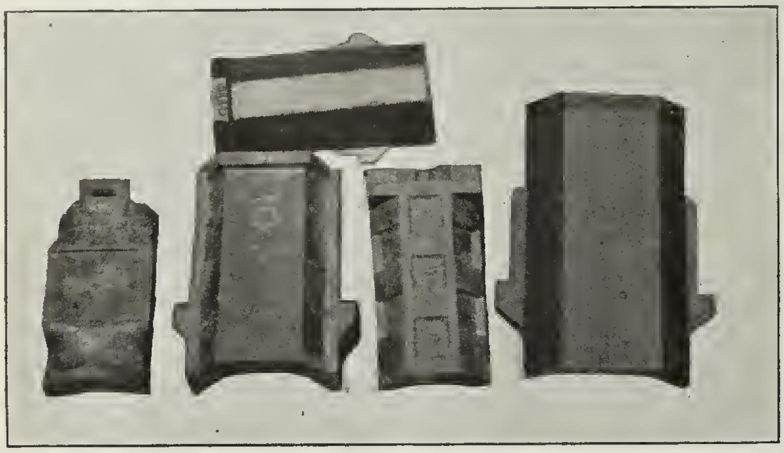


FIG. 2—A FEW OF THE MANY TYPES OF RAILROAD CAR JOURNAL BEARINGS

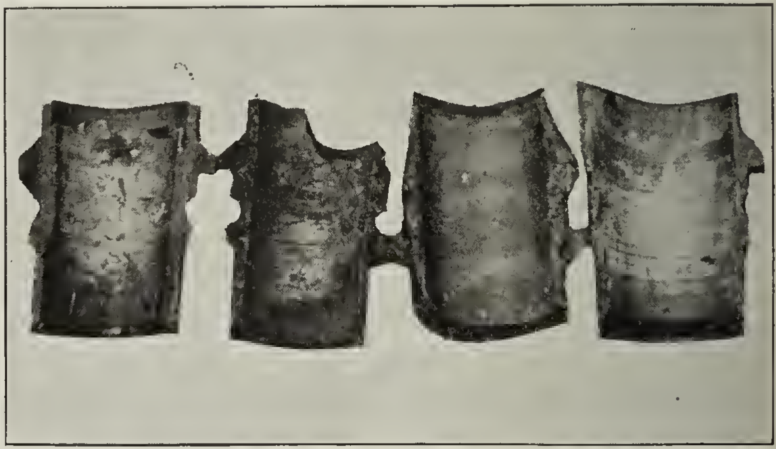


FIG. 3—TROUBLE-MAKING JOURNAL BEARINGS REMOVED FROM CARS

ing alone warrant this consideration while the amply service-proven fact of the oft-imposed necessity of the journal to resort to the naked brass altogether, as its bearing metal gives additional force to the argument. An impressive observation in examining returned scrap bearings is that in many such cases evidences of most serious hot-box conditions are seldom lacking. It is admitted, of course, that the heated condition may have preceded journal-with-brass association and been responsible for it in a number of cases, though the opposite is quite as logical and evidence-warranted to assume in as many instances. Copper-tin-lead with a minimum of zinc is doubtless the logical combination though as has been ably and justly brought out by G. H. Clamer, of the Ajax Metal Co., that in formulating and recommending a standard mix for this purpose, some provision will have to be made for a while at least to permit the railroads service disposition of scrap from the great bulk of badly zinc-contaminated and sterling judgment and practice in governing control. All scrap lining metal suffers one combining melting and at least three remeltings before re-entering the service from which it came as a scrap metal. Our experience has been that no antimonial-lead can go through these from four to five processes and retain its quality unimpaired. In scrap form, the lining metal is returned with the bearing and usually clinging to it. The mass of bearings are thrown into a large burning-off pot and the lining metal melted off. By melting off in large quantity, carefully controling the temperature to avoid burning, pigging and analyzing each lot separately and figuring it in small quantities into and along with new material, the situation can be satisfactorily controled and the scrap disposed of. An exemplary composition of one of these lots as analytically determined reads lead, 85.75 per cent; tin, 2.53 per cent, and antimony, 11.79 per cent. A good practice that can be resorted to for purifying this scrap metal consists in immersing a good sized block of dry hickory wood in the pot, allowing the metal to boil 15 or 20 minutes and skimming the dross from the surface as it develops.

Melting the Metal

In process of combining its constituent elements and in manipulation, this lining metal should be accorded the same sterling practice. Overheating the metal in any stage makes it hard, brittle and oxide-including, all of which are on intimate terms with the hot-running journal. In this, as in every other field of non-ferrous service, the oxide evil is one of the most detrimental to results and embodies in its seriousness the great necessity for well-regulated precaution against its development. Correlatively we might remark that the same consideration applies to the copper-base alloy used in the bearing back. In manufacturing the lining alloy from its elements, two reputable practices are admissible. The first is to melt first in the iron pot a quantity of lead equal to the antimony to be used, crush this into small pieces, add it to the lead bath and cover with crushed charcoal while it slowly melts. At complete dissolution, add the remainder of the lead, stir thoroughly and pig. The other method, which is the quicker and better, consists of melting the elements separately, the lead in the iron pot and the antimony in a crucible, and combining them in their liquid state. In either case, superheating must be carefully guarded against.

Exaggerated porosity in the lining metal is a prevalent source of hot-box trouble. Surface-occurring, as shown in *B*, Fig. 1, these little cavities become receptacles of collecting dirt and grime which harden in them and attack the revolving journal. The consequence is the journal is scored and the hot box at once dickered with. From the very beginning it must be understood that smooth surfaces in both bearing and journal are alone inherently capacitated to repel the inroads of friction as recorded in heat. Sources of this porosity are varied. It may occur from overheating the metal, from pouring it at improper temperature, from a chilled mandrel, a steaming bearing back at time of pouring or from bad metal. It can follow also an oxidized lining surface in the bearing back. The steaming of the back and its oxidized bearing surface are the only items calling for comment. Paradoxical as it may appear, a water-soaked bearing is a possibility. It very often follows shaking castings out at high temperature and immersing them in water, as in tumbling barrel operation. Following this practice, we have known bearings even after boring and then tinned and preheated, to steam perceptibly and blow the filling metal back out when poured into the opening between the bearing and the mandrel. On one occasion we were having this trouble and to make definitely sure of its source, had 50 bearings from the same metal as that giving trouble left in the mold until completely cold. In lining, not one of these 50 observed a blowing tendency. It is quite easy to connect the steaming of the surface with the porosity of the lining metal. The presence of included oxides or oxidized metal will produce a similar effect and behaves much the same as rust on iron. The lining metal observes a revolting attitude to the oxide's presence and records its displeasure in agitation throughout solidification with porosity resulting.

Loose Bearings Cause Trouble

In service, the loose bearing very often parts with its lining and imposes on the copper-base metal back a task to which it was never fully intended. It makes possible also a crushing-rolling up, a sort of a buckling of the lining metal. Many returned scrap bearings offer strong evidence of this condition to which heat development is always a probability. Binding and cramping follow with a still greater heating possibility. As with porosity, the loose bearing is a cause-varying consequence among which the following are significant: Dull tools in boring, improper and imperfect tinning, as indicated in *A*, Fig. 1, pouring the bearing when the bearing is in too cold a condition, permitting too long a time to intervene between boring and lining, pouring the lining metal too cold, poor grade or bad composition-ratio in tinning alloy, steaming of the bearing while pouring, oxidized tinning surface, and rough handling of the lined bearing in both heated and cold condition. A few remarks will suffice to point out the more important of these. Dull tools in boring seldom produce a clean cut. Instead, they merely bruise the rough surface, leaving it in no condition to tin properly. In tinning, best grade of material should be used and when tin and lead are jointly considered, the tin should never go below the common solder basis, which is 50-50. In pouring the lining metal, the tinned surface should never be much, if any, below the freezing point of the tinning compound. Throwing or dropping lined bearings with lined surface down on hard surfaces is always calculated to weaken the lining union. In lining a bearing a week after boring it, no surprise is due if trouble is experienced in getting a good tinned surface. The other considerations in this connection are too obvious to require comment. The loose bearing is an extremely serious service proposition and should be guarded against with maximum concern. Often, adhesion is weak or absent only in spots, but this is no mitigating argument. Every bearing should be tapped on the back with a hammer in three or four vicinities and in suspended position and dispatched to service only when the ring is true in each and every instance of tapping.

Smooth Bearing Surfaces

Science explains friction on the over-lapping of molecules. In the smoothest of surfaces in contact this condition prevails. As surfaces roughen, not only molecules, but even masses get a gripping chance at each other and friction with developing heat intensifies. The smooth bearing surface, therefore, is the only one logical. To this end mandrels should never be allowed to rust into uneven surfaces. Nor should they be subject to that abuse resulting in mutilation of these surfaces. Likewise with finished bearings. To nick or gash their lined surfaces by rough handling not only roughens them to greater friction, but also creates those grime-collecting receptacles already referred to. On bearings finished and ready for shipping the writer sometimes feels like stenciling the caution: "Handle With Care".

Suitable molding machines and good molding machine practice should be accorded the bearing back in the making. To minimize the oxide evil in the journal surface, all bearings should be cast with this surface in the drag half of the mold. Ample precaution should then be taken against cope swelling. In boring the bearing preparatory to lining, a clean fillet should be cut on the one end and a clean, smooth face machined on the other. To buff these ends on an emery wheel and let them go at that admits fine emery embedding in the brass and cutting the collar and fillet of the journal as they wear into the embedded emery. In all phases of manipulative practice precautionary measures against any such condition are important. We recall visiting a railroad foundry once and seeing a man buffing on an emery wheel the lining surfaces of some dozen or more bearings. The bearings were of new and larger type to the boring of which the foundry had not yet equipped its boring mills. Therefore, they were trying to buff a clean tinning surface on the journal side. Of course, no highly satisfactory tinning surface could be guaranteed by the process and what would happen to the journal if forced to meet this emery-polluted surface would scarcely require a gutta-percha imagination to divine.

Details in Practice

Many apparently insignificant yet important items of detail in practice might be further considered. Antimonial lead shrinks perceptibly in cooling. In pouring, the lining metal shrinks considerably below the end surface during this cooling process. This shrinkage, of course, is filled in with an additional supply. If done while the shrinking metal is yet plastic or granular, no parting line results. If delayed until complete solidity occurs in this shrinking mass, an open suture or line of union is nearly always in evidence. The results possible are imperfect union and a grime-accommodating crevice. To avoid tinning of surfaces not so intended, bearings are often painted with a wash of common clay or fire clay and water. To allow journal-engaging surfaces to carry this gritty coating into service is by no means, good, careful practice. By enormity of demand, journal bearings are produced as rapidly perhaps as any class of non-ferrous work doing extensive service today. A rapidly producing system is a good thing if all the little items of detail are accounted for and faithfully controled by the system. Otherwise it is not and regardless of increased capacity, no journal-bearing-producing system is justified if disregarding the many small details so vital to efficient bearing service demanded on railroad cars. By the same consuming demand, railroads find it expedient to take every advantage favoring reduction of journal price. From over-anxiety, principles of false economy are always liable to spring. A good journal bearing is like anything else that is good. It has a healthy equivalent in the coin of the realm.

Evils of Present Policy

The general policy of railroads is to use bearings as they come from the lining mandrels, the finishing process consisting of rough-trimming of the edges and ends. This practice imposes on service serious contentions with a hard surface-skin embodying surface impurities, with inequalities of surface arising from uneven shrinkage, and with a concealed porosity in the lining metal of many accepted bearings. That the situation involves its adverse consequence is a matter not foreign to the intelligence of motive power officials. They recognize the principle and apply it to their engine-truck and trailer brasses where service is similar in many respects to that of the car bearing. However, an engine put out of service is a different proposition from an incapacitated car. This fact, along with the tremendous preponderance of car over engine bearing demand has doubtless influenced motive power officials to deny the one that all along they have accorded the other. The practice, however, has fallen prey to a more sensitive suspicion and the indications are toward a change in method for experimental purpose at at least. The idea of boring a journal bearing after lining it is a sound one and has already been taken up by different roads. Change in conditions has much to do with the necessity for change in practice. The 3¾ and 4¼-inch journals, the 60,000 and 80,000-pound capacity cars and the 20 to 40 miles per hour train speeds belong to a closing era of rail history. In their stead have come greater things with greater achievements still in promise. What answered them in co-ordinating equipment will not answer now nor satisfy the future. Car-bearing service is becoming more and more exacting and will have to be catered to accordingly. In boring after lining the bearing as bored should still remain a crown bearing. This means that we must either add stock to the crown of the lining alone and then bore out the crown only or add stock uniformly and make two separate cuts, the distance of the bearing from the boring bar in the one cut to be greater than that in the other and the cutting tool so manipulated as to realize the double radii of the crown bearing surface. This consideration arises from the physical impossibility of generating more than one circle from a fixed tool revolving from a fixed center.

The second consideration has to do with the place where the linings are bored. If the foundry is a distributing center with the points where the bearings are applied to service far removed from it, then the boring should be done at the division point and not at the foundry. Unnecessary handling of bored bearings is wasteful and dangerous, and for these reasons shipping the machined bearings should be avoided as much as possible.

The Failure of Brass

"The Failure of Brass" is the title of a publication recently issued by the United States Bureau of Standards, which discusses the microstructure and initial stresses in wrought brasses of the type consisting of 60 per cent copper and 40 per cent zinc. Wrought brass bolts were the subject of the initial experimental investigation, in the course of which the physical properties, microstructure and initial stress distribution have been studied. Both failed and sound materials were obtained from the Catskill aqueduct construction, the filtration plant of the city of Minneapolis, the navy department and the Panama canal and new material was secured from a number of manufacturers, totaling 250 specimens. The results indicate that failure has occurred as the result of faulty practice in forging bolt heads, flanging plates, etc., as the result of the presence of initial stress, and as a result of service overstress due to drawing bolts up too tightly. This investigation shows that an average initial stress of 5,000 pounds per square inch is to be regarded as a safe limit for rods and bolts of this type of material under ordinary service conditions in which the service load itself is not greater than from 5,000 to 10,000 pounds per square inch.

Brass Cleaner and Deoxidizer

A new deoxidizer and cleaner for brass castings has been developed by E. D. Frohman, of the S. Obermayer Co., Pittsburgh. The purpose of this purifier is to eliminate the oxides which form in ladles or crucibles when melting non-ferrous metals. The purifier contains phosphorus, which combines with the oxides in the metal and reduces them, freeing the metallic elements. The phosphorus oxides formed by the reaction come up to the surface of the molten bath in the form of gas or skimmings. Also, it is stated that a small portion of the phosphorus combines with the copper in the mixture. The purifier does not act as a flux, but simply as a reducing agent.

When melting with flame-type furnaces, the purifier is preferably placed in the bottom of the ladle before pouring in the proportions of one pound of cleaner to every 500 pounds of molten metal. The reducing agent also may be mixed with the brass turnings and scrap before charging. For this purpose two pounds of purifier to 500 pounds of metal are required. Where ingot metal is used, the manufacturer recommends the addition in the furnace of one pound of cleaner to 500 pounds of metal. If the metal is melted in crucibles, one-half of this amount of reducing agent should be sufficient.

The manufacturer states that the use of this reducing agent will decrease the oxides in the skimmings from an average of 20 per cent to 0.5 per cent.

The production of copper in Arizona in 1916 is estimated at approximately 675,000,000 pounds, as compared with 432,000,000 pounds in 1915. This exceeds the total output of the United States as late as 1902. Michigan produced 269,000,000 pounds, as compared with 238,900,000 pounds in 1915. The output from Alaska, estimated at 120,000,000 pounds, compared with 70,600,000 pounds in 1915.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Welding Copper

In the squirrel cage rotor on the induction motors which we manufacture we use hard drawn bars in the laminated part and cast the copper end ring onto these projecting bars. However, we are experiencing considerable difficulty as a result of the cracking of the ring and the copper does not fuse rigidly to the copper bars. Have you any suggestions whereby we can overcome this difficulty?

We believe the difficulty outlined has caused some manufacturers to abandon this method of producing this type of rotor. It always will be found troublesome to fuse cast copper rigidly onto hard drawn bars, since the copper chills when it comes in contact with the cold metal. To satisfactorily burn or weld copper onto a cold surface of the same metal, a considerable amount of the molten metal must be blowed-off to heat the cold body of metal to the temperature at which union can occur. However, since this is not practical in this case, we suggest that some other method be devised. We are of the opinion that your difficulty could be overcome in a satisfactory manner with the aid of the oxy-acetylene torch.

Steam Metal Fixtures

What is the best mixture for a good steam metal for globe, angle and radiator valves, in which the metal is more or less thin due to the low pressure?

A good steam metal formula follows: Copper, 86 per cent; tin, 7 per cent; zinc, 4 per cent; lead 3 per cent.

A cheaper alloy for radiator valves follows: Copper, 87.5 per cent; tin, 3.5 per cent; zinc, 7 per cent, and lead, 2 per cent.

Another mixture, not as expensive as the foregoing, follows: Copper, 76 per cent; zinc, 10 per cent; lead, 10 per cent and tin, 4 per cent.

Of the three formulas given, No. 1 is to be preferred.

A Difficult Mixture to Cast

Recently we have been making large bronze plates, 14 x 18 inches in size and 1 inch thick, from a mixture containing copper, 148 pounds; tin, 20.50 pounds; lead, 19.25 pounds and 15 per cent phosphor-copper, 12.50 pounds. The castings are exceedingly porous and since they are designed to withstand a pressure of 2,000 pounds per square inch, are unsatisfactory.

Reduced to percentages, the above mixture figures about as follows: Copper, 79.31 per cent; tin, 10.25 per cent; lead, 9.50 per cent, and phosphorus, 0.94 per cent. This is practically the regular 80-copper, 10-tin and 10-lead alloy plus 1 per cent of phosphorus. It is a difficult mixture to cast and is susceptible to porosity. There is a proper temperature for pouring these high-phosphorus alloys very difficult to describe and if there is no one at hand with the necessary experience to determine this point, we suggest that the molds be made with a dry sand facing, coated with a plumbago wash and afterwards dried. Pour the metal cool and use care in melting. There are some alloys of copper, tin and lead, when the tin content is over 10 per cent, that cannot be cast to make sound castings by any ordinary method and the above alloy minus the phosphorus is one of them. With the phosphorus, sound castings can be obtained, but difficulty may be encountered at any time. The following alloy is recommended: Copper, 85.75 per cent; tin, 10.25 per cent; zinc, 2 per cent; lead, 2 per cent, and 15 per cent phosphorus copper.

Tobin Bronze

We would like to have mixtures for welding rods, such as Tobin bronze, manganese bronze, copper and aluminum.

The formula for Tobin bronze follows: Copper, 59¼ pounds; zinc, 40 pounds and tin, ¾ pounds.

Manganese bronze: Copper, 61.50 per cent; zinc, 36 per cent; iron, 1 per cent; tin, 0.75 per cent; aluminum, 0.25 per cent and manganese-copper, 0.5 per cent.

Copper: Copper, 98.25 per cent; tin, 1.25 per cent, and phosphor copper, 0.5 per cent.

Aluminum: Use pure aluminum.

An Anti-Acid Bronze

We would like to have a mixture for a tough alloy for making castings to be used as hangers on dipping trays that are submerged in a sulphuric acid solution. These castings are about 20 inches long and weigh 20 pounds each. The only acid bronze that we can find a record of contains copper, lead and antimony, but this is not sufficiently tough for our purpose.

We suggest the use of aluminum bronze, an alloy consisting of 92 per cent copper and 8 per cent aluminum being recommended. This mixture is strong and tough and will withstand the action of sulphuric acid as well as any metal that we can suggest.

No. 12 Aluminum

We would like to have you furnish us with the formula for No. 12 aluminum.

The formula for No. 12 aluminum follows: Aluminum, 92 per cent and copper, 8 per cent. This alloy is preferably made by the use of a hardening alloy consisting of 50 per cent copper and 50 per cent aluminum, 16 parts of which are melted with 84 parts of aluminum at as low a temperature as is consistent with the proper alloying of the metals. When melted, the alloy is fluxed with zinc chloride, after which it is removed from the furnace and poured.

Mixture for Aeroplane Motor Castings

We are engaged in the manufacture of large aeroplane motors and we would like to know the most suitable aluminum alloys for the cylinders, pistons, crank cases, etc., for these machines. Also let us know the composition and characteristics of aluminum alloys which you consider most suitable for these purposes. What should be the shrinkage allowance for patterns on aluminum castings and what are the common troubles experienced by foundries in doing this work?

One of the best aluminum alloys for the purpose outlined consists of aluminum, 93 per cent, and copper, 7 per cent. It is made by melting 86 per cent of aluminum with 14 per cent of a hardener composed of 50 per cent aluminum and 50 per cent copper. The patternmaker's allowance for shrinkage is 0.186 inch per foot. The common trouble experienced by foundries is porosity, which manifests itself in the form of black spots which are really dirt-filled holes. This is guarded against by pouring the metal in the molds at such a temperature which insures free running, but its congelation, almost immediately after it is cast, and the time of its contact with the sand in a liquid state is reduced to the minimum. A heavy aluminum casting poured at a temperature of 850 degrees Cent. will be porous, but when cast at 680 to 700 degrees Cent., such a casting will be sound. Therefore, do not pour the metal too hot.

Shrinkage Difficulties

We manufacture railway bearings, but when fractured they develop reddish brown discolorations and we have been unable to discover the cause of this difficulty.

An examination of the fractured surface of the sample casting submitted indicates the difficulty to be due to the shrinkage of the metal. The casting is of heavy section and has a reddish area in the center of the fracture, the ground mass being gray, uniformly interspersed with minute reddish spots. The absence of the gray constituent in the center is the cause of the reddish appearance of the fractured surface at this point, which manifests itself as a porous mass when the surface is machined. The remedy is to use feeders sufficiently large to keep the center filled with the lower melting gray constituent of the alloy, which in this case is rich in lead. The problem is one of properly feeding the casting and if this is not possible, chills should be resorted to. It long has been recognized that manganese bronze requires large risers to insure sound castings, but it is less generally known that ordinary copper-tin, copper-tin-lead and copper-tin-zinc alloys shrink just as badly, because manganese bronze shows shrinkage by a depression or a cavity. In conjunction with feeding by the use of risers, it is advisable to employ a suitable flux when melting the metal.

Mixing and Melting Yellow Brass

We would like to have several mixtures for yellow brass with instructions for melting this alloy.

A good casting alloy for general purposes follows: Copper, 75 per cent; zinc, 21 per cent; lead, 2 per cent, and tin, 2 per cent.

Naval brass.—Copper, 62 per cent; zinc, 37 per cent; tin, 1 per cent, and lead, 1 per cent.

A cheap casting mixture.—Copper, 67 per cent; zinc, 30 per cent; lead, 2 per cent, and tin, 1 per cent.

Casting brass.—Copper, 65 per cent; zinc, 32 per cent; iron, 1 per cent, and lead, 2 per cent.

Muntz metal.—Copper, 59.5 per cent; zinc, 40 per cent, and tin, 0.5 per cent.

These alloys are not difficult to make and the copper first should be melted under a cover of granular charcoal together with a small amount of salt. Have the zinc broken into small pieces and place it on the furnace top to heat while the copper is melting. When the latter is thoroughly liquid, add the zinc, one piece at a time, and stir well to thoroughly incorporate each piece before introducing more cold metal. When the zinc has been charged, follow with the lead and tin. Pour the metal strongly into the molds, keeping the heads filled, and pour hot rather than cool.

Rolling Mill Bearings

We would like to have mixtures for rolling mill bearings, as well as advice regarding melting.

Use the following mixture: Copper, 80.5 per cent; 30 per cent phosphor-copper, 1 per cent; tin, 11 per cent, and lead, 7.5 per cent. Melt the copper under charcoal, add the phosphor-copper, followed by the tin and the lead. Stir thoroughly and pour at a medium temperature.

Sizes of Stack and Flues for Melting Furnaces

We are planning the erection of a battery of six brass melting furnaces. We do not obtain a sufficient number of heats from our present equipment and we want to be sure that the new furnaces will give us better results. In your judgment, what should be the height of the stack? Also, what should be the inside diameter of the stack and the inside measurements of the flue box?

To make an intelligent reply to your inquiry it is necessary to know the height and diameter of the stack of the present furnaces, also the sizes of the main flue and the connecting flues from each furnace. The number of heats taken from each furnace should be stated and the number to be expected also should be given. In general, the height of the stack is comparatively unimportant as long as it extends above the buildings in the immediate vicinity. The dimensions of the stack inside, the main flue and connecting flues are the more important factors to be considered to obtain efficiency in melting. For six furnaces make the connecting flues 6 x 4 inches, the main flue 18 x 12 inches and the stack 24 x 18 inches and 40 feet high, or as much higher as may be necessary to carry it above the surrounding buildings.

Overcoming Porosity

We manufacture brass standards for steering wheels for large steamships. The standards are machined and we are having considerable trouble from porosity. We realize that this can be overcome by adding copper, but this will increase the cost of the mixture to a prohibitive figure. Can you suggest a cheap mixture of yellow brass that will work satisfactorily and finish nicely?

The following alloy will be satisfactory for the purpose suggested: Copper, 60 pounds; zinc, 40 pounds; tin, 0.5 pound; lead, 1 pound; manganese-copper, 0.25 pound and aluminum, 0.25 pound. This makes a total of 102 pounds for the mixture. The additional 2 pounds is to allow for zinc volatilization, so that the analysis will show between 39 and 40 per cent of this metal. This alloy will run well and will produce satisfactory castings if the proper precautions are exercised. It is a mistake to imagine that porosity can be overcome by the addition of copper, since the latter metal is not a deoxidizer and the porosity is due to the oxidation of the metal during the melting process. The remedy is better melting practice with the use of plenty of fine charcoal as a cover for the metal and the employment of a small amount of common salt as a flux.

How to Buy Pattern Lumber Economically

Pattern Lumber Specialists Understand Foundrymen's Needs—Buy the Most Economical Grade for Your Work—Study Local Conditions

By H Cole Estep

MURPHY, the pattern shop foreman, reported that his supply of lumber was about exhausted. So Brown, the manager of the plant, diverted a fragment of his attention from the weighty problems of the Saturday payroll long enough to settle the annoying detail that had been brought to his attention. He turned to his clerk and issued the following order:

"Call up the Polson Lumber Co. and tell them to send us a thousand feet of their best A-1 pattern lumber."

And straightway Brown forgot about pattern lumber. It is to the credit of the Polson Lumber Co., however, that it delivered the goods according to specifications. The Polsons were retail lumber dealers, and they kept, or tried to keep, a stock of all kinds of lumber for all sorts of purposes from dog houses to fine patterns and even furniture. They ransacked their stock and sent Brown "their best pattern lumber"—the best they had. The designation "A-1" meant nothing definite either to the lumber dealers or to Brown, the foundryman

So Brown got all he bargained for, including a bill for $90.30. It was not the lumber company's fault that he did not, as a matter of fact, obtain the best, or the most economical lumber for his purpose. The lumber dealers did 90 per cent of their business with local building contractors and they could hardly be expected to be familiar with the peculiar requirements of the foundry business or the patternmaker's art. Nor was it their fault that the tremendous inroads on the supply of standing timber in the last two decades has made it virtually impossible for anyone but a specialist to secure certain fancy grades of lumber. The Polson Lumber Co. took what it could get through the ordinary channels of the trade and worked as much for price as for quality. One result was that Brown was paying out more than the cost of his lumber every month in unnecessary labor in his pattern shop.

How the Specialist Can Help

Brown's situation was not unique. Hundreds of foundrymen all over the country cling to the time-honored custom of buying their pattern lumber from local dealers. Acting on the advice of their pattern shop foremen, they almost invariably specify "the best" without knowing what it is, and as a result they pay high prices and obtain, not the best, but merely the best the dealer happens to have on hand. These foundrymen have not yet learned that specialization counts in the pattern-lumber business as in other departments of the foundry industry.

Scarcity of Fine Lumber

In fact, as already suggested, the condition of the lumber market today is such that specialists have a great advantage in obtaining uniform grades of lumber suitable for patterns. The prodigal waste of the timber resources of America is proverbial. We have destroyed and burned our forests, until now we are in sight of the day when we shall have to go without. Among the ordinary woods, absolutely clear, straight, sound, flawless planks of fair size, say 1 x 10 inches x 16 feet, are a rare commodity. A prominent pattern-lumber dealer stated recently that he was six months picking out a carload of super-high-grade lumber of this character for a special purpose. Yet this is what many pattern shop foremen think they must have. As a matter of fact it is next to impossible to get it, and slightly lower grades of material, from a lumberman's standpoint, are in every way suitable. To put it another way, clear planks are to the lumberman what tool steel is to the metallurgist—fancy stuff—and no foundryman, under ordinary circumstances, would think of buying tool steel scrap for his cupola charges.

The conditions we have attempted to sketch in the foregoing paragraphs have created the pattern-lumber specialist, and it is to him that the progressive foundryman is turning to solve his pattern-shop raw-material problems. There are several large companies specializing on pattern lumber in the United States and their success testifies to the soundness of their position in the economic order. These organizations combine a knowledge of the requirements of the foundry and patternmaking industries with expert information on the lumber trade. Their resources are such that they are able to control certain high grades of lumber, suitable for patterns, from the time the tree is cut until the air-seasoned plank is delivered to the pattern shop racks. Such concerns are in touch with sources of lumber supply that ordinary local dealers cannot profitably reach.

Several pattern lumber specialists own their own standing timber, which has been carefully cruised and selected for the purpose intended. These concerns also frequently have sawing contracts with mills, which puts the mill in the position of a hired servant rather than that of a seller. All of these arrangements tend toward the conservation of the comparatively limited supply of high-grade pattern woods, for the benefit of the foundry industry.

The foundryman who expects to buy his pattern lumber economically must ask himself two questions. *First:* What is the best kind of lumber for me, considering the location of my shop and the sort of patterns I expect to make? *Second:* What is the most economical grade, considering pattern-shop wages, the time required to make the patterns I have in mind, and the waste in cheap lumber?

A Simple Lesson in Economics

Considering the first question, we find that in the northern, northeastern and middle western sections of the country white pine is one of the most widely used pattern woods. The reasons for this are obvious to every foundryman. Yet there are occasions when other, more durable woods should be substituted for pine. A certain Michigan gasoline engine factory made a pine pattern of a crank case for a new type of engine. The production had not reached the stage where a metal pattern would pay. But experience with the pine pattern soon showed that something representing an intermediate step between soft wood and metal was needed, for the pine pattern had to be returned to the shop for extensive repairs after it had been used for making 65 molds. After it was repaired, 65 more molds were made, when it was so dilapidated that it had to be replaced. In making the new pattern, mahogany was tried. Before the mahogany pattern had to be returned to the shop for attention it turned out 140 molds. After slight alterations it went through another run of 238 molds. The pine lumber cost about $100 per thousand board-feet and the mahogany $180. Yet it was cheaper in the end. On the other hand, had only 40 or 50 molds been desired, or perhaps a lesser number, pine would have been much preferable, not only on account of its lower first cost, but because it is more easily worked and cuts down the pattern-shop labor.

In brief, the selection of the proper kind of pattern lumber is purely a question of dollars and cents that a foundryman should be able to work out from his pattern-shop records. The same applies to the grade of lumber employed. It is a pattern-shop axiom that the cost of the pattern is in the labor required to make it. This is not literally true at present, owing to the extremely high price of the very best grades of lumber. The cost of the raw material in these days is an item to be reckoned with as well as labor costs in pattern construction. Occasionally money can be saved by using lumber of a grade somewhat lower than the proverbial best.

An Endless Labyrinth

When the foundryman gets into this question of lumber grading, however, he frequently finds himself in an endless labyrinth. In the first place the various lumber manufacturers' associations have separate grading schedules pertaining to their particular products. Secondly, lumber usually is graded by inspectors who represent the producers rather than the consumers. In many cases, the so-called independent inspectors, although not in the employ of any individual manufacturer, represent the lumber industry as a whole. Finally, in spite of the honesty of the grading—and practically all of it is fair and square—there is a prolific source of dispute and misunderstanding in the fact that after all it is largely a matter of opinion. The grader looks at a plank and classifies according to his judgment of its appearance. Lumber cannot be graded on the basis of definite, measureable constituents like pig iron.

Large concerns meet this situation by employing experts to inspect their purchases and make it certain that the specifications are being lived up to. Obviously, the ordinary foundryman cannot go to this expense to inspect three or four carloads of pattern lumber a year. His most satisfactory course of action lies in picking out a reliable specialist in pattern lumber whom he can take into his confidence and on whose judgment of lumber values from a pattern-shop standpoint he can rely. If he will follow this policy, and will back it up with suitable, simple patternshop records that will tell in black and white what really is the most economical lumber for certain classes of patterns, all factors considered, he will have made a long step forward in the solution of his pattern lumber problems.

Different Kinds of Pattern Lumber

Now a word about the physical characteristics of the various common pattern woods. Pine and mahogany already have been mentioned. In the same general class with pine are the spruces, hemlock, redwood, certain varieties of cedar, etc. Of the evergreen woods, however, northern white pine, sometimes called cork pine or sugar pine, appears to be the king of soft woods for pattern construction. It can be worked easily to a smooth surface; it does not split readily; it is easy to pare and does not dull tools as fast as some other varieties of lumber. It also has a sufficiently fine grain to take a high polish with shellac varnishes. When properly dried and varnished, it exhibits remarkable resistance to the warping and swelling action of damp molding sand. Spruce, redwood, Port Oxford cedar, etc., are used in the Rocky mountain and Pacific coast districts. They are not as uniform and readily worked as northern white pine.

Poplar, or white wood, is frequently used for making patterns. It has a fine texture and a satin luster. It shrinks moderately and can be given a fine finish with shellac. Some grades warp more readily than pine, but it is a dry wood that does not absorb moisture readily. In this connection, it might be pointed out that trees growing on high ground, on account of their dense texture and comparative freedom from moisture, are usually preferred for pattern lumber to those growing in wet, swampy localities.

Among the hardwoods, mahogany and cherry appear to be the most popular. They are both dense, straight-grained wood of uniform texture. They are impervious to moisture and take an unusually fine polish. Also they resist wear in a satisfactory manner and, as previously pointed out, make more durable patterns than the soft woods. On the other hand, they are more expensive than pine or its associated soft woods and are harder to work, increasing the labor cost on given patterns. So in the last analysis, the selection of pattern wood is purely a question of dollars and cents, based on the use to which the pattern is to be put. The same kind of lumber cannot economically be used for all purposes.

Similar principles apply in the selection of flask lumber, except that in this case local lumber-market conditions form the governing factor. The life of the ordinary wooden flask is so short, due to burning and general abuse, that only the cheapest sort of lumber is economical. This, of course, does not apply to small, highly-finished, metal-bound snap flasks, but to common flasks used in floor molding. Under ordinary circumstances it does not pay to ship flask lumber any great distance. Therefore, in the northwest we find that fir is a favorite; in California it is redwood or cedar; in the middle west, spruce, Norway pine, yellow pine or low grades of white pine are employed. For similar reasons foundrymen in Borneo may use teak for flasks, while their fellow craftsman in southern Ohio buy wormy chestnut.

Lenoir Car Works Installs Open Hearth

David McLain, Goldsmith building, Milwaukee, has completed negotiations for the installation of a 2-3-ton open-hearth furnace in the plant of the Lenoir Car Works, Lenoir City, Tenn. This furnace is guaranteed to melt five 2-ton or two 2-ton and two 3-ton heats in 12 hours, and the temperature of the metal will be such that the smallest castings made in the average crucible steel foundry may be poured successfully. This is the fourth furnace of this type for which David McLain has received contracts in less than a year.

Limestone for Cupola Flux

By *W. J. Keep*

Question:—We would like to have the analysis of a good limestone to be used as a cupola flux. What is the permissible maximum content of magnesium carbonate, silicon, phosphorus, iron, aluminum and sulphur and what is the permissible minimum content of calcium carbonate? In other words, would the presence of 10 per cent magnesium carbonate, 0.40 per cent silicon or 0.004 per cent phosphorus be objectionable?

Answer:—It is difficult to obtain a limestone containing less than 10 per cent magnesium carbonate. If it were all lime it would be preferable. It is quite common to have stone containing 40 per cent of magnesia, when it becomes a dolomite and is of no use for cupola fluxing purposes. Such a small percentage of silicon will do no harm and the phosphorus content will prove beneficial rather than detrimental. The carbonate of lime should be 86 per cent. The danger is in the content of iron pyrites, which appear in dark patches and in this form it all enters the iron. The following analyses were made of samples of western Lake Erie limestone and the iron contained in the sample from Sibley, Mich., namely 2 per cent, might spoil a heat:

Analysis of limestone from Marblehead, O.—Calcium carbonate, 83.20 per cent; magnesium carbonate, 15.83 per cent; silica, 0.15 per cent; organic matter, 0.02 per cent, and moisture, 0.80 per cent.

Kelley Island limestone.—Calcium carbonate, 87.50 per cent; magnesium carbonate, 9.75 per cent; silica, 1.81 per cent; alumina, 0.75 per cent; phosphorus, 0.01 per cent, and magnesia by difference, 0.17 per cent.

Sibley, Mich., limestone.—Calcium carbonate, 98.48 per cent; magnesium carbonate, 0.15 per cent; silica, 0.17 per cent, and moisture, 1.20 per cent.

Another limestone sample from Sibley, Mich.—Calcium carbonate, 86 per cent; magnesium carbonate, 9 per cent; silica, 3 per cent, and iron, 2 per cent.

Charles J. Stark Appointed Editor of The Iron Trade Review

Charles J. Stark, associate editor of *The Iron Trade Review*, located at the New York office of the Penton Publishing Co., has been appointed editor of this publication to fill the position formerly occupied by George Smart, resigned. Mr. Stark has been connected with the editorial staff of *The Iron Trade Review* for more than a decade and he brings to his new position the fruits of mature study of the iron and steel industry of the United States, as well as the broad viewpoint resulting from a wide acquaintance among both producers and consumers of iron, steel and machinery products. He joined the staff of *The Iron Trade Review* as associate editor at Cleveland, in 1907, and the following year he became Pittsburgh representative. In February, 1910, he was transferred to New York and since that time has had charge of the metropolitan office of the Penton Publishing Co., publisher of *The Foundry, The Iron Trade Review* and *The Daily Iron Trade and Metal Market Report.* Mr. Stark will assume his new duties about April 1.

To fill the vacancy created by the promotion of Mr. Stark, Edgar C. Kreutzberg has been appointed associate editor in charge of the New York office. He also will continue to serve as associate editor of *The Foundry* and of *The Daily Iron Trade and Metal Market Report.* Mr. Kreutzberg has been in the New York office of the Penton Publishing Co. for four years and is thoroughly familiar with the eastern field.

Mr. Kreutzberg's former position in the New York office will be filled by Guy F. Creveling, who has been connected with the Penton Publishing Co. in an editorial capacity since October, 1912.

How to Eliminate Sulphur Holes in Castings

By Edgar Allen Custer Jr.

The concensus of opinion among foundrymen, and, in fact, among all those who are in any way connected with the casting of iron, seems to be that as a maker of scrap and a profit reducer, sulphur stands in a class by itself. It is undoubtedly true that it receives more attention and is watched far closer than any of the other elements that control the grade of iron, and poor mixtures and resultant scrap piles are frequently said to be due to the pernicious influence of this element. We are all, more or less, familiar with the general overhauling that follows its appearance in excess, in which everyone, from the chemist to the laborer on the charging floor (not omitting the coke salesman), comes in for his share, yet the tendency in every case seems to be directed toward the keeping the sulphur as low as possible rather than to correct, insofar as it is possible, its evil tendencies in the casting.

The results of sulphur in excess are threefold. It causes a reduction in tensile strength; it increases the shrinkage; and results in the appearance of numerous gas holes familiarly known as sulphur holes. It is the last of these factors that causes the most serious loss to foundrymen, since the first two are not necessarily fatal to the casting. The deterioration in the physical qualities in a great many instances is not sufficiently great to preclude the use of the casting, and the excessive shrinkage may be overcome by the intelligent use of risers and feeders.

Gas Holes a Bugbear

The question of gas holes, however, is one that no foundryman can afford to overlook, since nothing will injure a foundry's reputation so much as tales of hours of machining and labor lost when the machinist's tool opens up a series of these sulphur holes.

A particularly erratic car of coke, together with a series of errors of commission and ommission in a certain foundry not long ago caused more than usual interest to be taken in the sulphur question, and a series of experiments were undertaken in an effort to dodge the overdose of sulphur. Omitting mention of the numerous changes in cupola mixtures and the various forms of cupola operation, sane and otherwise, that were tried out, the direct result of the investigation was as follows:

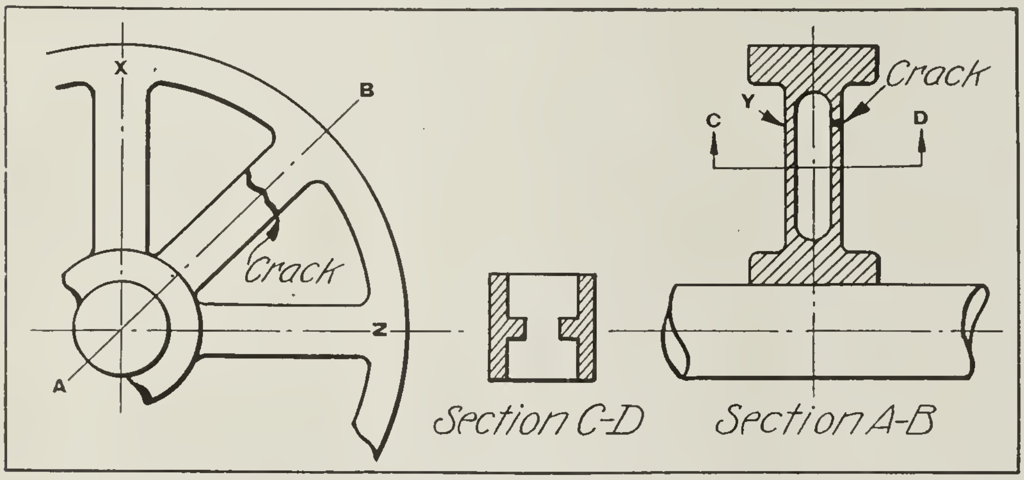
It was first observed that regardless of the chemical composition of the iron, whether it be high or low in any or all of its elements, when in a molten state it is a homogeneous mass. The carbon is all combined carbon, and the sulphur, manganese, etc., are in chemical composition with the iron. Assuming that this theory is correct, it is evident that segregation must occur after cooling has started. This is most effectively proved by the fact that the ratio of combined carbon and free of graphitic carbon is determined almost entirely by the rate of cooling. The more rapid the cooling, the greater the amount of combined carbon.

It was next observed that when special mixtures are formed containing sulphur decidedly in excess, the resultant castings invariably contain a large number of sulphur holes, yet when the same mixture is drawn off into a ladle and allowed to solidify, it is found to be free from these holes. This gave rise to the natural theory that the formation of these holes is a result of the process of casting and not a result of ordinary segregation.

Lessons from Holes

From the very nature of these holes it is apparent that sulphur must be combined with some other element to produce a gas, since the affinity of sulphur to the iron or to the other elements is too great to allow it to exist in a free form. It also was argued that when sulphur is segregating, it must be doing so under the influence of some element for which it has a greater affinity than it has for any of the elements contained in the mixture. The question of a possible combination with other elements in the mixture was dropped because these gas formations, while existing in the casting, did not exist in the open ladle even though the analysis proved these mixtures identical. If this be so, it at once becomes apparent that the formation of sulphur holes must result from the introduction of some other element after the metal has left the ladle and entered the mold. The possibility of gas forming combinations resulting from the action of the hot iron on the sand of the mold, rendering gaseous any of the elements contained in the sand or binder, was obviated by the use of an iron mold, in which the test castings were cast. The first two or three pours served to burn off all foreign matter adhering to the mold leaving the matrix practically naked iron. It was found, however, that the same mixture of high sulphur iron develops gas holes in direct ratio to the velocity of pouring, making it seem that the method of introducing the iron into the mold is directly responsible for the formation of the gas holes.

Since by successive steps it was proved that the formation of the gas holes results from the union with some element not contained in the mixture, and that this union takes place between leaving the ladle and filling the mold, there is but one theory left, and that is that the iron was trapping air and carrying it with it into the mold. It was reasoned, and later proved correct, that the iron, as it flows into the gate, carried air with it in precisely the same manner that a stream of water carries air with it as it runs into a glass of water. The size and number of the sulphur holes decreased or increased according to the speed of the iron in the gate. If poured slowly, the buoyancy of the air was sufficient to cause it to rise against the flow of the iron and escape through the gate, but as the speed of the iron was increased, it overcame this buoyancy and carried the air with it into the mold. This air, or rather its oxygen content highly heated by contact with the hot iron, will unite with practically every element with which it comes into contact, according to the relative affinity of the oxygen for the elements.



SECTIONS OF A BROKEN ROTOR CASTING REPAIRED BY THE ARC WELDING PROCESS

A Novel Theory

Of the elements contained in cast iron, at pouring temperature, oxygen has probably the greatest affinity for sulphur, uniting to form sulphur dioxide, which, when the small particles unite, forms the troublesome gas holes. This theory was further strengthened by noticing the odor accompanying the pouring. When the iron runs from the cupola into the ladle it necessarily must carry air with it, but as the surface of the iron in the ladle is free, the air, and the gas that is formed by the union of the oxygen and the sulphur, are free to escape, the gas being detected by the strong pungent odor of sulphur dioxide. After the ladle has been removed from the cupola and the ebullition has ceased, no odor is noticeable, yet when the metal is again poured into the mold the gas is again noticed, and is more or less noticeable according to the rate of pouring. This would indicate that the quantity of gas formed depends upon the amount of air trapped by the iron.

It remained, therefore, only to prove the theory by applying the remedy. The latter was applied in several ways, all of which depended on the principle of checking the flow of iron in the gate behind a trap, and allowing the air to release itself before entering the mold. The most efficient gate for this purpose seemed to be the type often used in brass and bronze molding to catch dross. The iron flows into a spherical or cylindrical cavity tangentially, setting up a swirl within the cavity. The discharge is in the center of the base of this cavity and leads down and across into the mold. The iron flows into this cavity and by swirling around allows the air and gas to escape through the top of the cylinder, which is open, while the iron, still high in sulphur, but free from gas holes, flows into the mold.

With this type of gate it was found entirely practicable to produce castings absolutely free from gas holes, yet the analysis often showed a sulphur content over 2 per cent. Of course, the resultant castings could hardly be considered serviceable with such a high sulphur content, because the physical qualitities were too greatly impaired.

Repairing a Large Casting by Electric Arc Welding

By H. A. Baltes

RECLAIMING gray iron castings by electric arc welding has been a much disputed subject. The successes attained by some firms is counterbalanced by the failures of others, who have been unable to make satisfactory welds or repairs. In no sense is this due to the type of equipment employed, this being entirely dependent upon the operator doing the work. When undertaking repairs by this process, the relative expansion and contraction of the casting or part to be welded must be thoroughly studied to prevent the cracking of the weld or adjacent parts of the original casting, while the latter is returning to its normal condition.

Soft cast iron welds cannot be obtained without properly preheating the parts to be welded. Welding a small defect in a large body of cast iron without preheating the casting causes the iron to chill rapidly. The parts immediately surrounding the weld, being cold, will produce a spot of chilled iron in the weld, which the best grades of high-speed tool steel will not cut. This may be eliminated readily by properly preheating the parts to be welded.

It is generally understood that the carbon in cast iron has the power to distribute itself uniformly, not only through one piece, but through several pieces in contact. When a high percentage of carbon is present the formation of graphite is favored. It is believed that cast iron containing a high percentage of carbon, liberates this element when heated and distributes it through the parts being welded, as well as the parts immediately adjoining the weld, thus imparting to the spot that is being welded an unusually high percentage of graphite and making the weld soft and readily machinable.

A concrete illustration of the results that may be attained by arc welding is the repair of a gray iron rotor casting weighing 16,000 pounds, which was reclaimed at one-twentieth of the original cost and at a saving of months of delay in securing a new casting.

The rotor was shipped from England to a firm in Canada and was to be pressed onto the shaft of a Canadian-built air compressor. The arms of this rotor, as shown in the accompanying illustration, were cast with a hollow center, and as indicated by the arrow, only one member of the arm was broken. It was imperative to have the compressor working within a specified time, so that it was practically out of the question to obtain a new rotor from the manufacturer in England. Our welding expert was consulted and he was convinced that the rotor could be repaired satisfactorily. Before beginning work, the problem of expansion and contraction was considered carefully, since this was the most important factor to determine. We decided that the casting had to be preheated at that point where the adjacent arms joined the rim of the rotor and also that member of the arm which was not broken. The points at which torches were applied are designated at *X*, *Y* and *Z*, in the accompanying illustration. As previously stated, the success of a welding operation of this kind depends largely upon the skill of the operator and his ability to determine the relative expansion and contraction.

Time of Welding

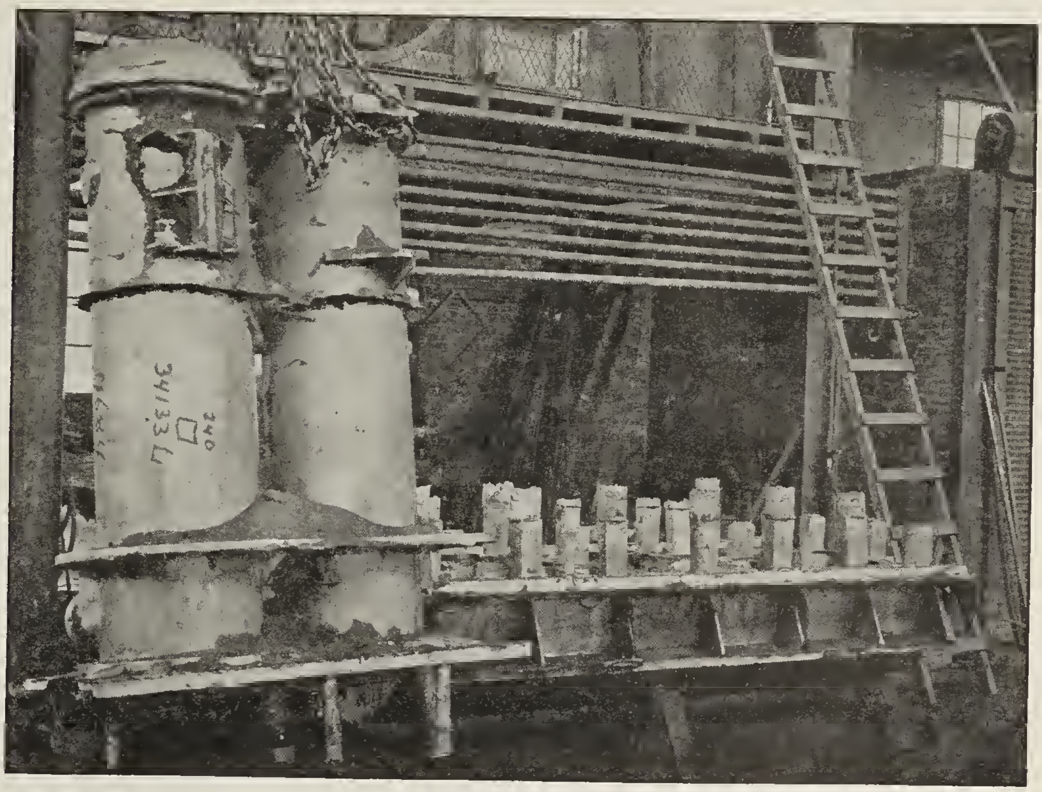
The time of welding, which included preheating, was approximately eight hours and was accomplished as follows: First, the windings were removed about half way around the rotor and the crack was cut out in a V-shaped groove. A dam was built around the arm with carbon blocks, cement having been used to bind them and to prevent the fluid metal from running through the joints. The cement was made of powdered carbon and sodium silicate. Charcoal fires, retained by fire brick, were built at points *X*, *Y* and *Z*, as shown in the accompanying illustration. The member to be welded was insulated from the heat applied to the unbroken member of the broken arm by fire brick held in place by a steel band, ½ inch thick. When the casting was heated to a cherry red at the points where the fire was applied, the welding operation was performed.

After heating the walls of the groove to a plastic state with the arc, the groove was filled with a good grade of high silicon iron. The fires were removed and the casting was allowed to cool slowly, that all parts might assume a normal condition. The customer was of the opinion that the rotor would be thrown out of alignment and that the diameter would be reduced at the point directly opposite the welded arm; however, instead of being smaller at that point, it was found to be ⅛ inch larger. This was remedied by grinding the rotor down to its original diameter. Otherwise the alignment was perfect.

After the casting had cooled, the windings were replaced in their respective slots, the rotor was returned to position and the machine was put in operation.

Vanadium Bronze Submarine Castings

The requirements of the United States government and the entente allies for submarine equipment during the past two years have created a heavy demand for special bronze castings suited to vessels of this character. Vanadium-bronze has been found to fulfill the exacting conditions of this work satisfactorily, and this alloy is now extensively employed in the manufacture of Deisel engines, torpedo tubes, etc. The accompanying illustration shows two vanadium-bronze castings for American submarines under contract by the Electric Boat Co. Two torpedo tube castings are shown at the left, together with a Deisel engine bed-plate at the right.



VANADIUM-BRONZE CASTINGS FOR DEISEL ENGINE BED AND SUBMARINE TORPEDO TUBES, WITH GATES AND RISERS ATTACHED

To insure sound metal, the latter is provided with 18 risers. Each riser is about 2½ inches square and 7 inches high. This casting weighs 4,000 pounds. The torpedo tubes are cast on end as they appear in the illustration. The walls of the rough castings are ¾ inch thick, and in order to remove all traces of surface imperfections they are turned to ⅜ inch in the machine shop.

The vanadium-bronze from which these castings are made contains 60 per cent copper and about 40 per cent zinc. Only a small quantity of vanadium is employed. The metal is melted in a reverberatory furnace, which is considered satisfactory for high-zinc alloys of this character.

The production of chromic iron ore in 1916, it is estimated, will exceed 35,000 tons, as compared with 1,000 tons in 1914 and 3,281 tons in 1915. This tremendous increase in domestic production has been made in spite of largely increased imports. Cromite is an efficient refractory material for lining furnaces and for making chrome brick and steel alloys, the demand for which has largely increased.

"Movies" of Molding Operations

George L. Grimes, Midland Machine Co., Detroit, manufacturer of molding machines, told members of the Pittsburgh Foundrymen's Association how intricate automobile castings are made, at the regular monthly meeting of the society, held Feb. 19, at the Fort Pitt hotel. A number of lantern slides, showing various types of molding machines, were presented and motion pictures were introduced to show how some of the larger foundries in the Detroit district make castings for the automobile industry. One of the films, produced in the foundry of the Packard Motor Co., Detroit, showed the molding of an engine cylinder, the coring of the molds, the gaging of the cores and work on the pouring floor. Another film showed the molding, closing and pouring of an automobile transmission case, and the molding of an automobile exhaust manifold.

The production of spelter from domestic ore in 1916 is estimated at 553,000 short tons, worth at the average St. Louis price about $150,000,000, and from foreign ore at 105,000 tons, a total of 658,000 tons.

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Contents

MAKING GRAY IRON ART WORK........ 85
ESSENTIAL FACTORS IN FOUNDRY COST ACCOUNTING........ 90
CUPOLA CHARGING........ 93
BOOK REVIEW........ 93
USE OF FLOOD LIGHTS IN INDUSTRIES........ 94
THE SEASONING OF CASTINGS........ 96
SLOW MELTING AND BRIDGING........ 97
MAKING LARGE PURE ALUMINUM CASTINGS........ 98
ANNUAL MEETING OF TESTING SOCIETY........ 98
MOLDING WHEELS AND SHEAVES WITH STEEL SPOKES........ 99
FIGURING THE COST OF THE CUPOLA HEAT........ 102
BELT SLINGS FOR CORES........ 102
PROTECTIVE COATINGS: LACQUERS—I........ 103
FOUNDRY EQUIPMENT CO. EXTENDS PLANT........ 105
WESTINGHOUSE COMPANY WILL BUILD........ 105
HOW HEAVY AMMONIA STILLS ARE MOLDED........ 107
WHAT FOUNDRYMEN CAN DO TO PREVENT HOT BOXES........ 111
THE FAILURE OF BRASS........ 114
BRASS CLEANER AND DEOXIDIZER........ 114
PROBLEM OF THE BRASS FOUNDRY........ 115
WELDING COPPER........ 115
STEAM METAL FIXTURES........ 115
A DIFFICULT MIXTURE TO CAST........ 115
TOBIN BRONZE........ 115
ANTI-ACID BRONZE........ 115
NO. 12 ALUMINUM........ 115
MIXTURE FOR AEROPLANE MOTOR CASTINGS........ 116
SHRINKAGE DIFFICULTIES........ 116
MIXING AND MELTING YELLOW BRASS........ 116
ROLLING MILL BEARINGS........ 116
SIZE OF STACK AND FLUES FOR MELTING FURNACES........ 116
OVERCOMING POROSITY........ 116
HOW TO BUY PATTERN LUMBER ECONOMICALLY........ 117
LENIOR CAR WORKS INSTALLS OPEN HEARTH........ 118
LIMESTONE FOR CUPOLA FLUX........ 118
CHARLES J. STARK APPOINTED EDITOR OF THE IRON TRADE REVIEW.. 119
HOW TO ELIMINATE SULPHUR HOLES IN CASTINGS........ 119
REPAIRING A LARGE CASTING BY ELECTRIC ARC WELDING........ 120
CONTENTS........ 122
ARE YOU DOING YOUR SHARE?........ 122
NEW EQUIPMENT FOR THE FOUNDRY AND PATTERN SHOP........ 123
WHAT THE FOUNDRIES ARE DOING........ 126

Are You Doing Your Share?

NOT long ago the editor of a well known trade journal offered to prepare an illustrated article describing certain interesting features of operation in a modern casting plant. In reply to the editor's communication, the proprietor of the foundry expressed his refusal to co-operate in the following words:

If, as you say, we have devised novel methods in our foundry, it has been with the intention of either improving our product or decreasing our cost. To do this has required brains, energy and money, an investment from which we hope to derive returns. We don't wish to appear selfish, but having made this investment, we hardly care to turn it over to competitors, as would be the case if we permitted the publication of the details of our process. That being the case, you can readily appreciate that we would not care for the write-up which you suggest.

Fortunately the number of business men who hold the view expressed by this foundryman is comparatively limited, and is decreasing every day. However, it is this group which is retarding progress and in justice to the casting industry, we propose to show why the close-fisted policy expressed is contrary to the principles of sound business.

In the first place, the foundryman quoted is wrong in believing that the methods employed in his plant constitute secrets which he should guard. Were any process in his establishment possessed of sufficient merit to make it of unusual value to his competitors, he would be powerless to prevent them from learning every detail if they chose to investigate. As a matter of fact, the methods employed in his foundry are well known to scores of tradesmen. Moreover, this foundryman makes the serious mistake of inferring that the alleged "secrets" of his business are the children of *his* brain and *his* money. Either he is honestly deceived in this belief, or he is deliberately claiming credit to which he is not entitled, because he has incorporated in the design and organization of his plant the ideas of hundreds of men. Unwittingly, perhaps, he has forgotten that Bessemer, Reamur, Turner, Bell, Boydon, West, Moldenke, Keep, and others have paved the way for his success. We wonder how he would have fared, had these men refused to divulge the priceless knowledge which their experience provided. This foundryman is a subscriber to several trade journals, and undoubtedly he reads in them the articles contributed by foundrymen whose vision is not as restricted as his. It is even possible that his competitors, from whom he is so carefully guarding his secrets, are silently contributing their share of experience to the industry through the pages of a trade paper. His attitude to them is eminently unfair.

Therefore, manufacturers whose first impulse is to hold tightly to the fruits of their experience, should consider the policy of publicity from an unselfish viewpoint.

New Equipment for the Foundry and Pattern Shop

Manufactures Molding Frame and Flask for Mechanically Drawing Pattern—Develops Enclosed Sand Blast Barrel for Large Castings

ANY mechanical device that draws the pattern greatly simplifies molding operations and eliminates a large part of the skill involved in this essential feature of foundry work. Combining mechanical pattern-drawing with mechanical ramming removes the skill of hand labor, increases production and insures a product that is true to pattern.

An ingenious molding frame and flask which draws the pattern mechanically and is adapted for use on any style molding machine or on the bench, is being manufactured by the New Foundry Appliance Co., Hamilton, O. To reduce its weight and to facilitate handling, the frame is made of aluminum and all attachments are malleable cast iron. The frame is lined with brass to permit of easily soldering metal patterns and gates to it. The frame is interposed between the drag and cope flask or between a sand or plaster match and the flask, and either the cope and drag can be made in one operation or the drag can be rammed first, followed by the cope. By the operation of a lever the cope is lifted and the pattern is drawn mechanically, after which the mold is lifted off.

In the accompanying illustrations, Fig. 1 shows the operator turning the lever, thereby raising the cope and drawing the pattern. In Fig. 2 the cope has been lifted off and the operator is removing the frame, which is clearly illustrated in Fig. 3. The method of attaching this gate of four patterns to the frame is illustrated and the construction of the frame also is shown. The drag half of the mold is still on the machine, which is of the squeezer type.

The lifting of the flask is accomplished by four rollers mounted on shafts, located in the corners of the frame. When the molding frame is in position for raising the mold, the rollers are flush with the surface of the frame; turning the lever actuates the rollers which lift the cope flask and draw the pattern. The rollers contact with metal strips on the corners of the flask to insure a level bearing surface and one which will be subjected to the minimum amount of wear. The frame is provided with extensions on the four corners for rapping patterns by hand and an ear is on one of the handles for the attachment of a vibrator. The molding frame can be used with either straight or tapered flasks. The flask pins are furnished as a part of the equipment so that any flask can be equipped for operations with the frame.

The handles on the frame are adjustable to the pins with lock nuts, thereby insuring accurate draws and eliminating all possiblty of shifting. Aluminum matchplates can be used with this frame by attaching them to the top of the frame with screws. The frame has a draw of 1½ inches.

The plant of the Peerless Foundry Co., Hamilton, O., which specializes in light gray iron castings, is oper-

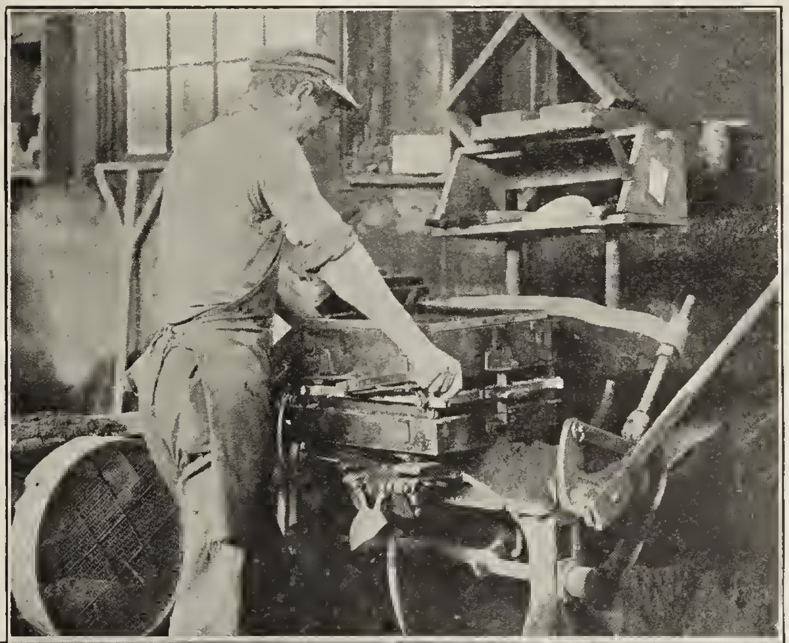

FIG. 1—DRAWING THE PATTERN BY THE USE OF A MOLDING FRAME WHICH LIFTS THE COPE BY TURNING THE LEVER AT THE FRONT

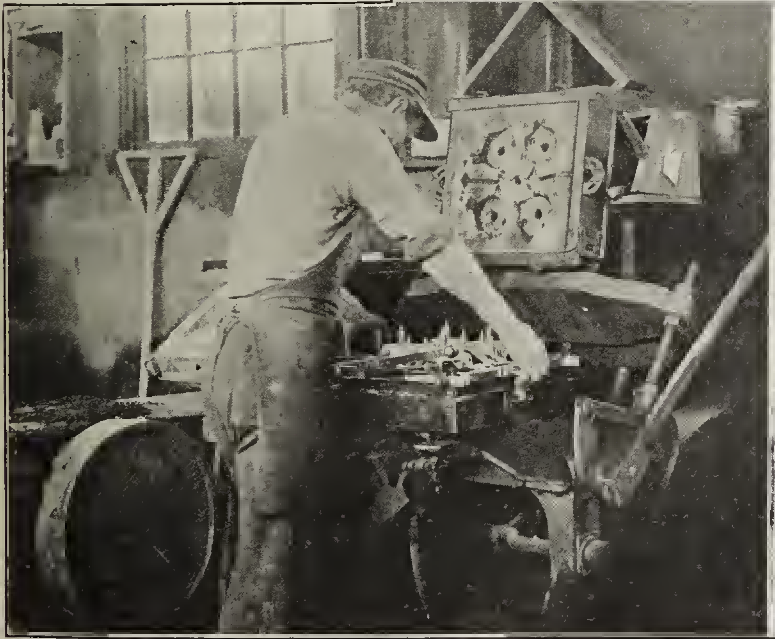

FIG. 2—COPE LIFTED OFF AND THE OPERATOR IS REMOVING THE FRAME FROM THE DRAG

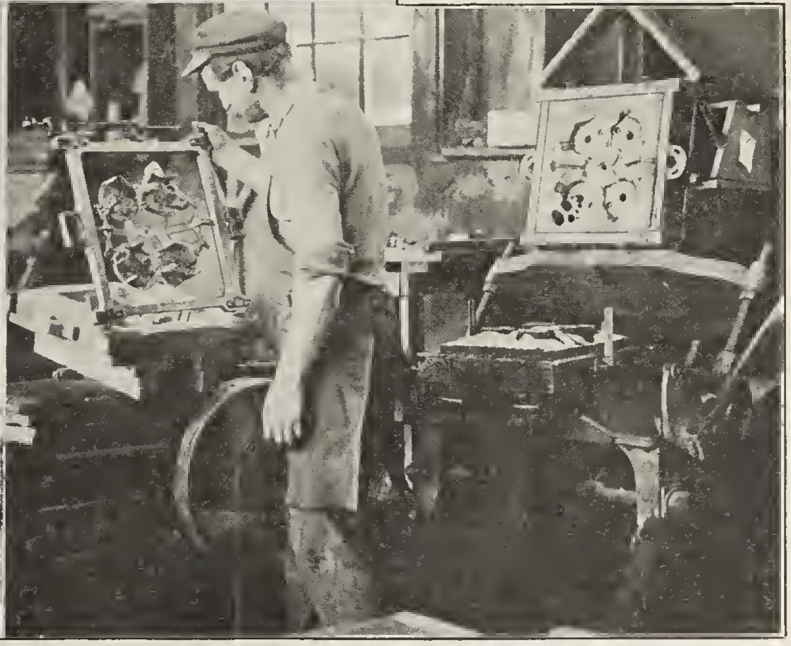

FIG. 3—FRAME AND PATTERN READY TO PLACE ON THE MATCH-PLATE AFTER THE MOLD HAS BEEN COMPLETED

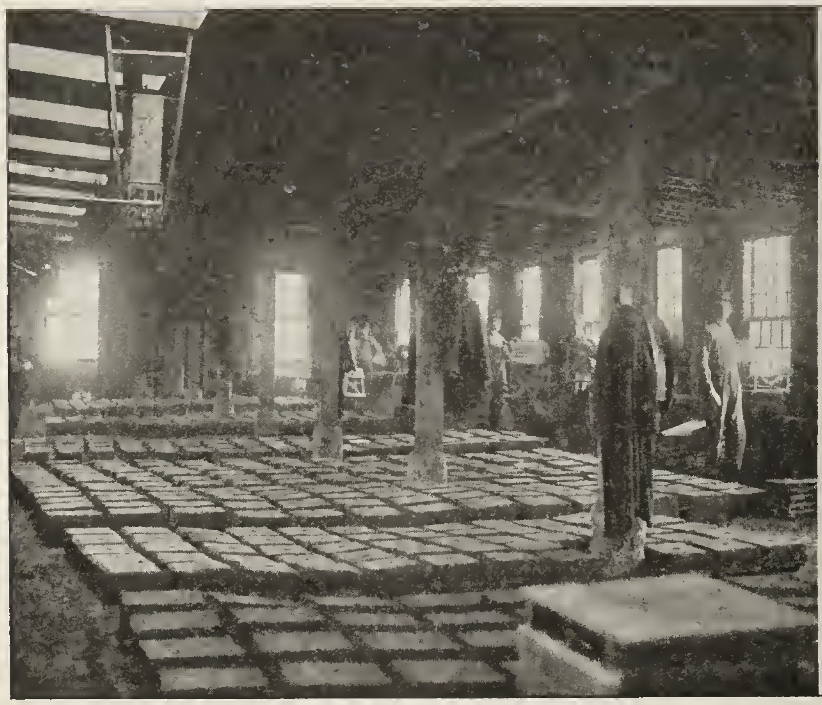

FIG. 4—LARGE OUTPUT OF UNSKILLED OPERATIVES WHO USE THE MOLDING FRAME

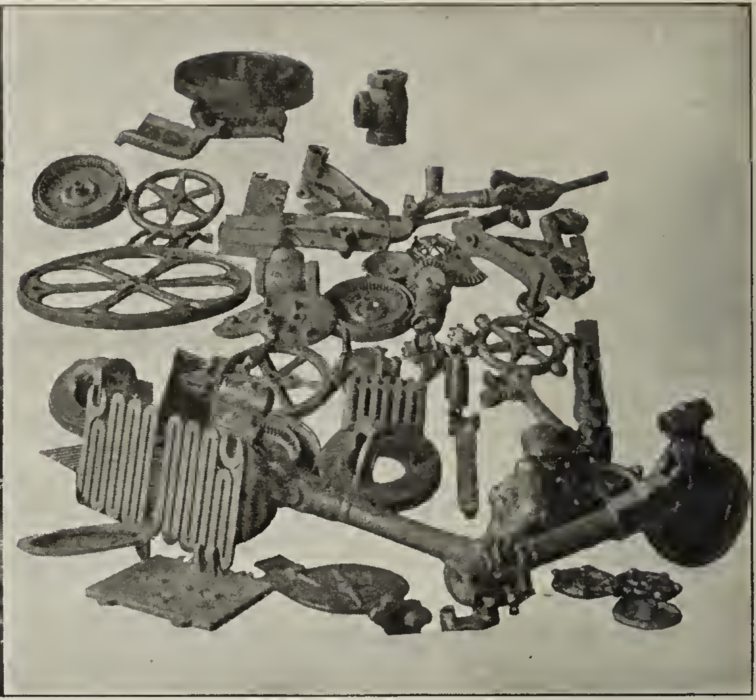

FIG. 5—MISCELLANEOUS CASTINGS MADE BY THE USE OF THE MOLDING FRAME

ated exclusively by this molding frame process. A wing of this foundry is shown in Fig. 4, the size of the floors being particularly noteworthy, since none of the men in this part of the shop had been engaged in molding more than one week when this photograph was made. It will be noted that all of the work in this department is made by the use of this molding frame. The wide variety of work that can be made by the use of this special frame is clearly illustrated in Fig. 5.

In addition to the molding frame shown, the New Foundry Appliance Co. manufactures flasks equipped with the adjustable pin and ear. The pins are machined inside and outside and are adjusted with lock nuts indicated at *A*, Fig. 6.

Screw Counting Machine

A machine used to count a definite number of screws and to deliver them into a package was recently developed by the Reynolds Pattern & Machine Co., Moline, Ill. It is used in hardware manufacturing plants, where it is necessary to pack a certain number of screws with each article sent out, these screws being used by the purchaser in assembling. In operating the machine, the package is set on a pad on the end of a lever located below a chute. When a lever is depressed, the proper number of screws slide down the chute into the package.

The Independent Pneumatic Tool Co., Chicago, is distributing a four-page folder, which illustrates and describes its line of portable electric drills and grinders. These tools consist of eight different sizes of electric drills with capacities ranging from ¼ to 2 inches and a portable electric grinder carrying a wheel, ¾ x 4 inches.

Develops Large Sand-Blast Barrel

In response to a demand for a sand-blast barrel of sufficient strength and size to clean heavy steel castings, the American Foundry Equipment Co., New York, has developed a machine which is larger than any of this type previously manufactured by this company. The drum or barrel proper is made of steel throughout and is securely riveted. It is 60 inches in diameter and 36 inches long, inside measurements. As the blast enters at each end of the drum, there are no projections on the interior and, therefore, castings can be loaded to within a few inches of the center line. This permits the handling of unusually large castings of medium weight in this machine.

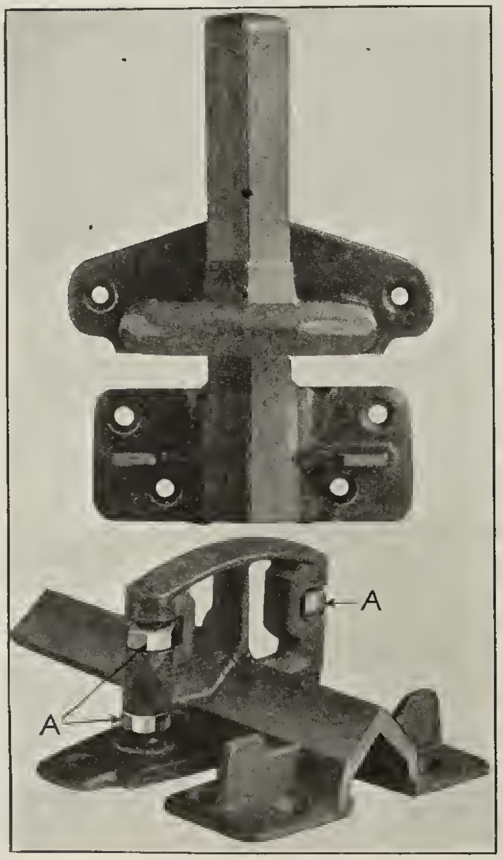

FIG. 6 — ADJUSTABLE PIN AND EAR WHICH IS A PART OF THE FLASK EQUIPMENT FOR THE USE OF THE MOLDING FRAME

The lower casing of the machine is made of heavy cast sections. The drum revolves on hardened machine steel rolls mounted on heavy shafting running in bronze bushings, the whole being supported on the frame by cast steel journal boxes. The casing above the journal is made of steel plate and structural shapes.

Removal of Dust

Provision is made in the casing for the removal of dust as soon as it is made, the air entering the casing through louvres in the doors. The machine is equipped with an underground pressure tank provided with a filling valve and air control sand trap, which automatically controls the operation of the blast when the machine is started or stopped.

The barrel is driven through worm gearing by a 3-horsepower motor, the entire outfit being a complete and self-contained unit. The machine requires a floor space of approximately 6 x 8 feet and when installed stands 8 feet above the floor level. The pit for the pressure tank is 5 feet 6 inches deep. The capacity varies through a wide range depending on the number and size of nozzles used, the pressure available and the material being sand-blasted. Fig. 1 is a front view of the machine and Fig. 2 is a similar view with the doors open and the barrel door let down to charge or remove castings.

Personals

L. E. Marseau has been appointed superintendent of the foundry operated by the Gartland-Toledo Foundry Co., Toledo, O.

H. I. Landis has been elected president of the Lansdale Foundry Co., Lansdale, Pa., manufacturer of light and medium gray iron castings.

James Ferris has been made general superintendent of the Kenosha, Wis., plant of the Simmons Mfg. Co., succeeding Otto Rudd, who has been elected second vice president.

Carl H. Swartz, formerly superintendent of the foundry operated by the W. T. Rawleigh Mfg. Co., Freeport, Ill., has established a gray iron foundry in that city.

T. S. Bird, formerly superintendent of the foundry operated by the Michigan Motor Casting Co., Flint, Mich., has accepted the position of general superintendent of the new Ecorse Foundry & Machine Co., Ecorse, Mich.

L. W. Lukens recently resigned as superintendent of the Illinois Malleable Iron Co., Chicago, in order to accept the position of foundry superintendent of the new plant of the Saginaw Malleable Iron Co., Saginaw, Mich. In his new position, Mr. Lukens will be associated with C. F. Drozeski, general manager. Mr. Lukens, who is widely known among western foundrymen, was connected with the Illinois Malleable Iron Co. continuously for 24 years.

Charles Page Perin, consulting engineer, New York City, for about 16 years, and Stewart M. Marshall, formerly chief engineer of the Cambria Steel Co., Johnstown, Pa., and recently chief engineer of the Southwark Foundry & Machine Co., Philadelphia, have formed a co-partnership as consulting engineers, with offices at No. 2 Rector street, New York.

Inquiry by Subscriber

Under date of Feb. 19 an inquiry was received from one of the readers of *The Foundry* signed "Subscriber". asking for a substance that can be used in place of plaster of paris for making temporary patterns. If this subscriber will furnish his name and address we will give him information direct regarding the source from which this material can be purchased.

Trade Notes

The New York office of the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., has been removed from 15 Wall street to the City Investing building, 165 Broadway.

The Union Smelting & Refining Co., Avenue D and Fourteenth street, New York, will erect a new plant on an 11-acre site on St. Charles street Newark, N. J. The plant ultimately will have five times the capacity of its present plant in New York City and will cost between $350,000 and $500,000. The first section of the new plant is expected to be completed in six or eight months. On its completion, the company will abandon its present plant in New York. The line of products will continue to include white metal alloys of all kinds.

The Associated Foundry Foremen of New York and vicinity will hold their next monthly meeting March 17, at 7:30 p. m., at the Hotel Chelsea, West Twenty-third street, near Seventh avenue, New York City.

The business of Cutter, Fletcher & Co., Inc., Boston, certified public accountants, has been transferred to the firm or Clinton H. Scovell & Co., industrial engineers, Boston, and the firm name has been changed to Scovell, Wellington & Co.

The Adams-Bagnall Electric Co., Cleveland, is completing the installation of a porcelain enameling plant. It consists of a battery of four 12-foot furnaces with the necessary complement of mixing vats, smelting furnaces, drying ovens, etc.

The Canton Metal Products Co., Canton, O., has taken over the business of the Canton Corrugating Co., and will engage in the manufacture of a complete line of sheet metal products, including foundry and factory equipment, such as shelving, bins, etc.

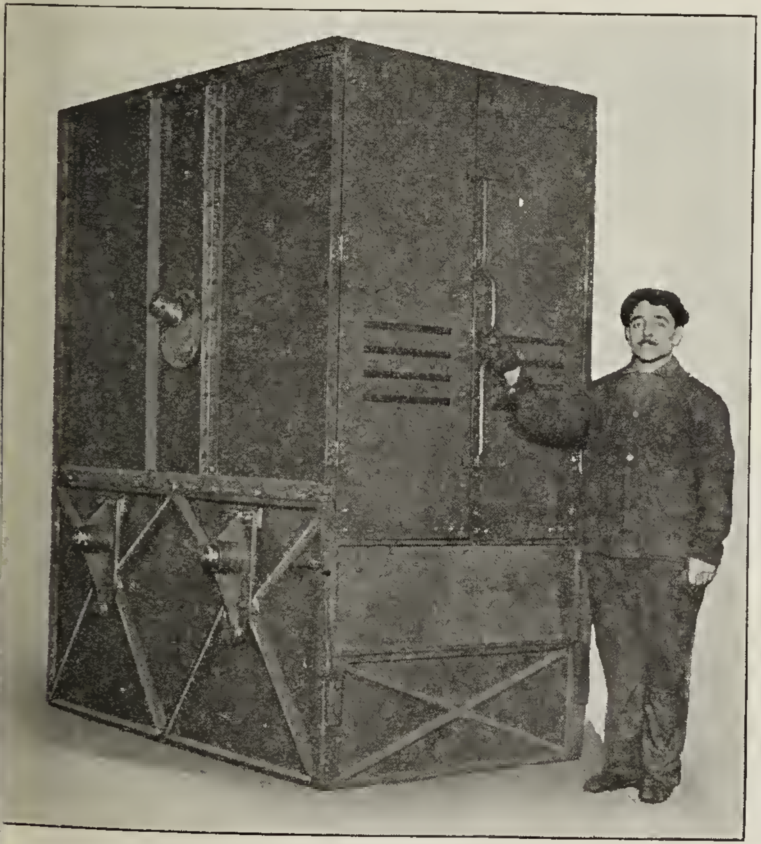

FIG. 1—VIEW OF EXTERIOR OF LARGE SAND BLAST BARREL

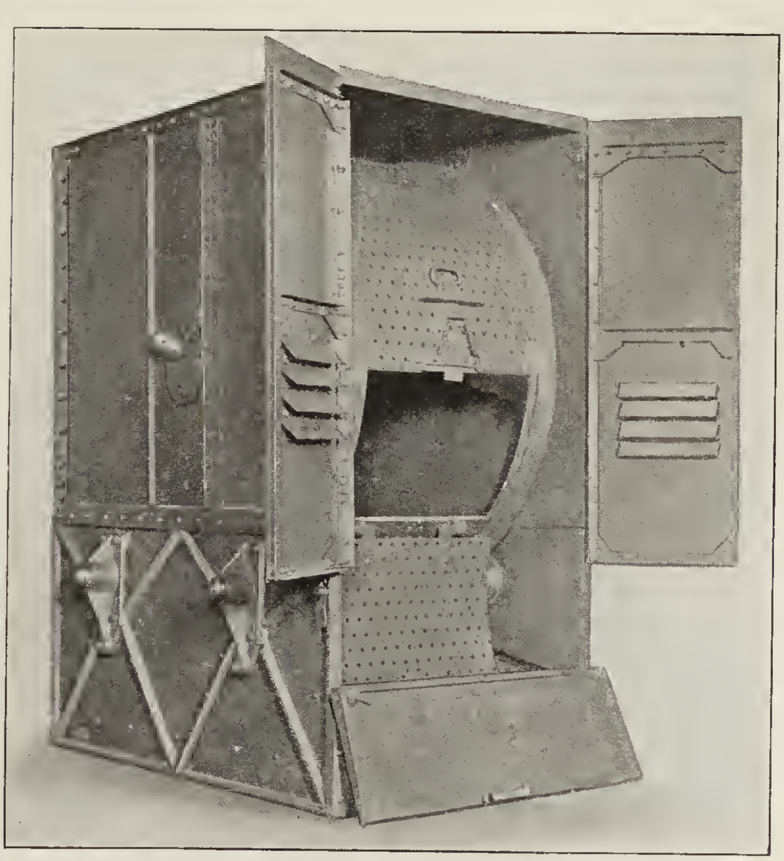

FIG. 2—ARRANGEMENT OF DOORS ON BARREL OF SAND BLAST MACHINE

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The foundry of the Mal-Gray Casting Co., Cambridge City, Ind., will be enlarged.

The Banner Foundry Co., Akron, O., will erect a steel foundry at 216 Newton street.

The Duquesne Reduction Co., Pittsburgh, contemplates building a foundry, 50 x 100 feet.

The Dixie Foundry Co., Cleveland, Tenn., is building a 60 x 120-foot addition to its plant.

The Saco-Lowell Shops, Lowell, Mass., will build a brick foundry addition, 125 x 168 x 170 feet.

The Buhl Malleable Co., Detroit, has increased its capital stock from $230,000 to $460,000.

The Ohio Mold & Foundry Co., Cincinnati, has increased its capital stock from $100,000 to $150,000.

Leslie V., John A. and C. H. Roake have incorporated the Oregon City Foundry with $20,000 capital.

The LaPoint Foundry Co., Schleisingerville, Wis., will build an 18 x 30-foot addition to its foundry.

Plans have been completed by the Central Foundry Co. for the erection of a 40-ton pipe plant at Bessemer, Ala.

The H. C. Macaulay Foundry Co., Berkeley, Cal., is building an addition to its plant at a cost of $40,000.

The Jakes Foundry Co., Nashville, Tenn., has been incorporated with $10,000 capital by Robert and J. W. Jakes.

The West Bend Aluminum Co., West Bend, Wis., contemplates the erection of a two-story, 50 x 260-foot addition.

Plans are being prepared for a 60 x 120-foot foundry to be erected for the Emerson Motor Co., Kingston, N. Y.

Plans are being drawn for a 60 x 240-foot foundry to be erected for the Caldwell Lawn Mower Co., Newburgh, N. Y.

The R. M. Eddy Foundry Co., 372 West Grand avenue, Chicago, has increased its capital stock from $150,000 to $200,000.

The East Bay Foundry Co., Oakland, Cal., recently incorporated with a capital stock of $20,000, will erect a gray iron foundry.

The Stubbs Foundry & Machine Co., Waco, Tex., will erect a foundry at a cost of $10,000, a pattern shop and a steel fabricating shop.

The Belleville Malleable Iron Foundry Co., Belleville, Ill., recently incorporated with $150,000 capital, will erect a malleable foundry.

The Valley Iron Works Co., Appleton, Wis., has increased its capital stock from $60,000 to $200,000 and will enlarge its plant.

The Dayton Malleable Iron Works, Ironton, O., will build two wings, extending the foundry 120 feet and the annealing room 150 feet.

A contract has been awarded by the American Radiator Co., Titusville, Pa., for the erection of an 80 x 100-foot addition to its foundry.

The Richmond Malleable Castings Co., Richmond, Ind., has been incorporated with a capital stock of $100,000. The officers of the company follow: John M. Lontz, president; H. R. Lontz, vice president and treasurer; W. J. Blackmore, secretary and general manager and G. B. Cavelage, superintendent.

The Taylor Coupler & Steel Castings Co., Toledo, O., has been incorporated with a capital stock of $100,000 by J. C. Taylor and L. S. Dukes.

The Framingham Machine Works, Framingham, Mass., is remodeling its plant into an iron foundry which will have an output of 60 tons daily.

The Empire Brass Mfg. Co., 8410 Lake avenue, Cleveland, will erect a brick and steel foundry at 10301 Berea road at a cost of $10,000.

The International Harvester Co. of New Jersey is building a 24 x 170-foot addition to its malleable foundry at 1734 Fullerton avenue, Chicago.

The City Brass Foundry Co., Detroit, has been incorporated with $2,000 capital stock by Frederick L. Maeder, Isaac Kaplan and H. H. Smilansky.

A contract has been awarded for the erection of a 150 x 200-foot addition to the foundry of the Davis & Furber Machine Co., North Andover, Mass.

The American Valve & Tank Co., Indianapolis, has completed plans for a foundry, 60 x 200 feet, to be erected at Fairmont, W. Va., at a cost of $35,000.

The Concord Foundry Co., Elkhart, Ind., has been incorporated with a capital of $50,000. The incorporators are J. G. Schacht, S. E. Schacht and Earnest A. Skinner.

The H. & H. Foundry Co., Stamford, Conn., has been incorporated with a capital of $20,000 by Benjamin Harris, John Hansen, East Port Chester, Conn., and C. P. Webb.

The Railway Supply & Equipment Co., Seward, Pa., has reopened its plant, which has been idle for two months. W. C. Greer has been appointed foundry superintendent.

The Clover Foundry has been incorporated to engage in a general foundry business with $50,000 capital stock. Charles S., Charles M. and H. W. Clover are the incorporators.

The Studebaker Corporation, Detroit, shortly will erect a continuous gray iron foundry, 140 x 450 feet, equipped with three cupolas, at its South Bend, Ind., plant.

The Youngstown Foundry & Machine Co., Youngstown, O., contemplates the purchase of a site on which to locate its two foundries which the company is considering merging.

Plans have been prepared for a large foundry to be erected by the National Malleable Castings Co., Cleveland. Approximately 3,500 tons of steel are to be used in its construction.

The Champion Foundry & Machine Co., Chicago, Ill., has been incorporated with a capital of $40,000 by A. E. Nelson, S. C. Larson and E. L. Kreamer, 7 South Dearborn street.

The Southern Machine & Foundry Co., Nshville, Tenn., has been incorporated with a capital stock of $35,000 by S. S. Warren, E. and S. Hartsfeld, C. A. Schneider and H. L. Scott.

The K. M. Brass & Aluminum Casting Co., 10611 Quincy avenue, Cleveland, has purchased 6½ acres on the Erie railroad on which it contemplates erecting a plant at a cost of $100,000.

A contract has been awarded by A. Allan & Son, 386 Greenwich street, New York, for the erection of a 50 x 180-foot foundry for the manufacture of non-ferrous metal alloys, at Harrison, N. J.

The McAdamite-Aluminum Co. has succeeded the United States McAdamite Metal Co., 57 Isabella avenue, Detroit, and will continue the foundry business of the old company under the same management.

The Bridgeford Mfg. Co., Louisville, has been incorporated with $184,000 capital stock to engage in the operation of a stove foundry. The incorporators are J. W. Campbell, George Leff and P. C. Doerhoefer.

The Detroit Brass Works, Detroit, has increased its capital from $400,000 to $500,000. The Detroit Valve & Fittings Co., which is taking over the former company, has increased its capital from $500,000 to $1,500,000.

The St. Louis, Iron Mountain & Southern railroad contemplates erecting a foundry at its shops at Argenta, Ark., for the manufacture of freight car parts and repairs. E. A. Hadley, St. Louis, is chief engineer.

The Atlas Foundry & Machine Co., Tacoma, Wash., is building a foundry addition, including a pattern shop, 40 x 225 feet. Additional ground has been purchased and further extensions will be made this year.

The Axelson Machine Works, Los Angeles, Cal., will build a plant including a foundry, 100 x 156 feet; machine shop, 75 x 125 feet; forge shop, 25 x 75 feet; pattern shop, 75 x 126 feet; pattern storage, 25 x 30 feet, and office building, 30 x 100 feet.

Plans have been completed for the erection of an ingot mold plant at West Middlesex, Pa., for the Valley Mold & Iron Co., Sharpsville, Pa. The plant will have a capacity of 100 ingot molds a day and is expected to be in operation within six months.

The United States Steel Casting Co., recently incorporated with $1,000,000 capital, has purchased the property of the National Steel Casting Co., New Cumberland, W. Va., and will build another plant. The officers of the new company are as follows: Samuel Ungeleider, president; Jacob Adolph, vice president; Ray Muslin, secretary and Ralph B. Cohen, treasurer.

The Harrison Steel Castings Co., recently incorporated with a capital stock of $300,000, will erect an open-hearth steel foundry on a 25-acre plot of ground at Murphysboro, Ill. Bids are being received on a foundry building, 260 x 180 feet and a cleaning department building, 160 x 140 feet. The company will install two 15-ton open-hearth furnaces, to be designed for either oil or powdered coal fuel, one 25-ton and one 10-ton crane, with a 70-foot span, in the foundry and one 10-ton crane, with a 55-foot span, in the cleaning room building. The officers are J. W. Harrison, president; R. J. Harrison, vice president and G. W. Harrison, secretary and treasurer. The general offices will be located at Attica, Ind., the Chicago office, 522 McCormick building and office and works at Murphysboro, Ill.

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The American Foundry in a Time of War

Lessons in Shell-Making From the Experience of French Foundrymen —Semi-Steel in Demand—Slip-Shod Methods Cannot be Tolerated

By Edgar Allen Custer Jr.

IN THE summer of 1914, when the European powers suddenly found themselves face to face with the stupendous task of not only raising and equipping huge armies, but of keeping them constantly supplied with the necessary munitions of war, they proceeded, as systematically and deliberately as the mad rush of events permitted, to organize their industries to the highest possible point of capacity and efficiency. Not only did they tax their own capacity to the utmost but they called upon all the outside help available. Tremendous orders were placed here in America for all sizes and varieties of shells, shrapnel, fuses, and other military stores. We in turn swung our industrial organizations as rapidly as possible into line for high pressure production. Huge tracts of land were plowed up and concrete foundations sprung up, almost overnight, the forerunners of buildings of a size and capacity hardly even dreamed of before. The country was combed from coast to coast for the necessary machines to equip the new shops and every machine tool builder suddenly found himself confronted with his dream of dreams, gigantic orders to be had for the taking.

The Tide of Fortune

The tide of fortune swung on to the foundries and they in turn bent every effort to the task of satisfying the insistent demands of their customers. Patterns for machine housings were swung into the pits while the sand was still hot from the housing pulled out but a short time before. Night gangs were put to work cleaning up and preparing for the day force. In many cases buildings were enlarged. Sheds and outbuildings were constructed around the foundry for overflow molding operations. Every effort was made to meet the sudden demand.

In Europe the same scene was being enacted, more grimly and earnestly perhaps and with the knowledge that their very existence hung in the balance, yet probably with no greater individual effort. The far famed German preparedness and efficiency had, no doubt, forseen and provided for every detail even to the precise quantity and grade of each type of casting in each foundry. Conditions in France, England and other

countries, however, more closely resembled our own state of affairs, each foundry working to its utmost but with a lack of unity and co-ordination so characteristic of the foundry trade. Each shop produced according to its own methods. Some specialized on heavy castings. Some turned to light work, as their equipment dictated. Various shops used widely different brands of iron for similar work. All were guided solely by the aim to produce in quantity and have sound, strong and easily machined castings, and at first their product was satisfactory.

But as the war assumed greater and greater proportions a new phase began to make its appearance in the foundries. When the first great drives through Belgium and France had come to a standstill and the armies were deadlocked, each protected in endless miles of trenches, the artillery developed into the determining factor. The famous and terrible curtain of fire made its appearance, necessitating the rapid use of great quantities of large and small caliber guns. Every assault upon a trench was dependent upon the artillery preparation that preceded it, during which the concentrated fire from many guns literally blasted the trenches out of the ground and devastated the country for miles.

High Pressure Production

This meant an unceasing supply of projectiles in quantities increditable were it not for the results obtained, and necessitated not only a higher rate of production on the part of the manufacturer but rigid economy if it were to be maintained for any length of time.

As the deadlock wore on week after week it became more and more evident that victory would finally depend upon exhausting the enemy's resources and in an effort both to conserve resources by reducing the cost and to increase the rate of production, the cast-iron shell made its appearance. The first indication were fragments of German shells, picked up on the battlefields of France. They were unquestionably cast iron. Little attention was paid to this phenomenon at first, since cast-iron shells are by no means new. Every country used them more or less for target practice, and it was argued that the Germans were hard pressed and were down to the extremity of using their dummies and target practice shells in active service. But Germany proved far from exhausted and as their guns returned shot for shot, the cast iron shell became an everyday occurrence and, contrary to most beliefs and opinions, observations seemed to prove them just as efficient as the steel shell.

From no less authentic sources than the official French inspectors and from men high in financial and commercial circles, lately returned, we get the story of France's struggle, crowned with final success, to produce a cast iron shell that would measure up to the stringent French requirements. Quick to appreciate the possible economies and the advantages of an increase in the rate of munition production, the French foundries were called upon to produce cast iron shells and solve the problem of meeting chemical and physical requirements calculated to give a shell no less efficient than the steel shell. The exact details may be withheld until long after hostilities have ceased, but many accounts of losses of total heats and 50 and 75 per cent rejections and the final adoption of mixtures identical with our semi-steel, indicate that the struggle must have been difficult and costly.

American Foundries Should be Ready

With our own country today facing the crisis of her history and with the grave realization that, while highly improbable, it is by no means beyond the bounds of possibility that the safety of the nation may rest upon our manufacturing ability, it is well that our foundries be prepared to do their part. Should the demand for shells become so great or the pressure of needed economy so powerful, that we also should turn to the foundries for help it would be everlastingly to their credit if they were able at once to produce a satisfactory product.

The production of cast iron or semi-steel shells presents difficulties that heretofore few if any foundries have been called upon to meet. Not only must they withstand fracture, but they must also behave properly when fractured. Sufficient resistance to impact must exist to prevent fracture and possible detonation within the gun, under the action of the impact of the propelling charge, and at the same time the resistance must not be such that it interferes with the proper fragmentation when detonation occurs.

The range of the physical qualities is limited to almost one precise point that will give the proper fragmentation, and to obtain and maintain this point is essential. Too great a resistance to the bursting effect not only reduces the number of the fragments, but necessarily reduces the destructive capacity of the shell, since too great a proportion of the explosive force is needed to effect the bursting. On the other hand insufficient resistance results in excessive fragmentation in which the pieces are so small that they are not capable of serious damage and lose their velocity quickly, thereby reducing the destructive range of the shell.

A sound casting is absolutely essential, for blow holes, slag spots, spongy areas and shrink holes not only seriously impair the strength of the shell, but tend to interfere with proper marksmanship. The proportions and distribution of the weight of the shell are calculated to a nicety, and the concentricity and position of the center of gravity are the determining factors in governing the flight of the shell. Blow holes or shrink holes may cause enough unequal distribution in the weight of the shell to interfere with its balance in flight and cause it to take a course sufficiently apart from its figured trajectory to strike wide of the mark. Still far more serious is the possibility of a weak spot giving way under the impact in the gun and not only tearing the gun to pieces but endangering the lives of the gun crew. It goes without saying that the casting must be machinable, since a casting too hard to machine could not possibly come within the requirements for fragmentation.

To meet the conditions such requirements call for the average American foundry must make radical changes in its mode of operation. The chemical analysis of the heats must be *exact*, not approximate, as between such and such a percentage of carbon or silicon. Also they must be not only exact but consistent, each day's analysis, melting temperature and speed of operation must be a duplicate of the previous day. The molding conditions must absolutely preclude the possibility of blows, gas or dirty metal. The core making must be practically perfect and the handling of the metal rapid, even and free from delays or interruptions.

Cause of Rejections

Seventy-five per cent of the rejections the foundries of France suffered while endeavoring to produce satisfactory semi-steel shells could be traced directly to the analysis of the mixtures and to this point the American foundry will have to pay the strictest attention. The average foundryman today, while professing to mix his charges by chemical analysis, is forced to admit when questioned closely that he is only approximating the desired result. To be sure he is sufficiently close to meet the requirements a foundry is generally called upon to meet, yet his mode of cupola operation and metal selection would fall far short of producing satisfactory shells. Still further from success, would be the foundryman who mixes his charges by that delightfully uncertain method of accepting the salesman's guaranteed analysis for his iron and coke and "toning" it down with any sort of scrap he may have on hand. Still existing in the midst of the progress foundries have made in controling their analyses, and in a surprisingly large number of cases, we find the foundryman, generally the old timer who "didn't learn his trade from books", who scorns percentages and proportions and mixes his charges by his own rule of reason. His analysis consists of breaking one pig over another and examining the fracture, and his mixing is generally some of the soft and some of the hard and the rest of it scrap. The shell his foundry could produce may look like a shell in size and contour but there the resemblance ceases.

To successfully produce semi-steel shells designed for active service, the services of a chemist are absolutely essential. His control and authority should be absolute, and upon his shoulders should rest the burden of the full responsibility for the mixtures, and under his direction should come every detail that relates in any way to the chemical composition of the semi-steel. Every facility should be afforded him to make and record his various analyses and observations, and his equipment should include the scleroscope and micro-photographic outfit.

Analysis of Materials

Each car of pig iron should be sampled, resampled, carefully analyzed and piled in such a manner as to prevent confusion with any other pile. The piles should be lettered or numbered for future identification. Every car of coke must be of the highest grade both in respect to analysis and body, particular attention being paid to the sulphur, for a poor grade of coke or a coke too high in sulphur is capable of untold damage.

The ordinary method of using scrap must come under a ban if best results are to be obtained. Under no circumstances should the scrap be charged direct into the cupola as a part of mixture. It should be charged alone at the end of the heat and run off into pigs or chills. Each lot of recast pigs or chills must be kept separate and, as in the case of the pig iron, sampled, analyzed, piled and marked for identification. By so handling the scrap all possibility of error due to unknown qualities is eliminated.

The grade and character of the steel are of less importance, since, compared to cast iron, the analysis of ordinary steel is practically stable. A wide range of physical properties may be obtained in steel with practically no change in the chemical properties aside from the condition of the carbon, and as the carbon reverts entirely to combined carbon during the process of melting, the condition of the carbon in the steel has no bearing on the analysis of the semi-steel. In the production of semi-steel any ordinary grade of steel is serviceable, such as boiler scrap, steel stamping or punching scrap, etc., provided it is not so thin and light in section as to be bulky when charged into the cupola, thus interfering with the proper charging. The use of alloy steel is to be avoided as the attainment of the proper chemical and physical requirements for semi-steel shells is too delicate a proposition to risk the evil influence it may or may not have.

The preparing and charging of the cupola should be carried on under the direction of the chemist and with just as much care and attention to detail as the chemist uses in his laboratory determinations. The method of laying, lighting and burning-up the fire should absolutely eliminate the possibility of a poor start, for such a start may spoil a whole heat. The addition of extra fuel after a cupola is well under way, while it may have the desired effect of regaining the proper melting temperature, may also be just enough to upset the analysis sufficiently to result in poor fragmentation. Also a poor start means that quite a proportion of the first metal charged is melted at a temperature below that necessary to produce satisfactory semi-steel. This may result in as much as 20 or 30 per cent of the heat being unfit for use.

All pigs, whether they be from the blast furnace or remelted scrap, should be broken into short, fairly uniform sizes so they may be placed uniformly in the cupola and melt practically simultaneously. Small pigs also facilitate weighing and make it possible to reduce the charging error in weights from pounds to ounces. All components of the charge, whether they be iron, coke, steel or scrap, should be carefully weighed and charged according to formulas and the prescribed quantity of each should be just as close as it is practical to obtain, all guessing and approximating being avoided.

Importance of Cupola Operation

The average method of cupola operation in this country sets at nought any close or accurate work on the part of the chemist. Too often the work of weighing and charging is left to the care of the laborer on the platform who goes through the operations of weighing and charging with scant regard for anything except speed. Too often the given quantity is measured as so many average pigs, or so many buckets or forks of coke and generally some more for good measure. Such cupola operation may produce excellent sash weights or grate bars and some classes of heavy work, but it would be an absolute impossibility for shell work.

The melting temperature, as determined by the appearance of the metal as it flows from the cupola, should be kept as constant as possible and at a temperature slightly above normal, in order that the timing operations for handling and pouring can be reduced to a science. Semi-steel, like cast iron, will absorb or throw off impurities according to its melting temperature, absorbing impurities, particularly sulphur, when the temperature is too low, and throwing them off when high, so it is essential that the temperature be kept as high as possible, although care must be taken not to burn the metal.

In handling the metal, it was found that the best results could be obtained by using a specially constructed receiving ladle under the spout of the cupola. This ladle, mounted on trunnions, is so constructed or so lined up that the metal flowing over the lip is drawn from the bottom of the ladle, similar to a spout or skimming crucible. This effect can be obtained by taking an ordinary large foundry ladle and placing a fire brick partition running down just behind the lip, parallel to the side of the ladle, to a point several inches from the bottom. The metal to flow over the lip must then first flow down behind the partition, under it and up over the lip. This insures clean metal and gives the air and gas an opportunity to escape off the surface of the metal in the ladle. It performs the functions of a mixing ladle.

Ladle Preheating

The metal should then be transported as rapidly as possible in small ladles with but one change in order to eliminate any unnecessary chilling or oxidizing of the metal.

All ladles and the cupola spout should be thoroughly dried before using and the ladles should be kept over a fire or in a warm place until it is time to use them. The first metal down should be used to preheat both the large and small ladles and then poured into the chills or pigs. Metal which shows any boiling or agitation due to an imperfectly dried lining should never be used even though it eventually comes to rest. Such iron should be poured into the pig bed. When the ladle is once heated up it should be kept going constantly until the end of the heat to prevent its getting cold and chilling the metal.

Second in importance to the chemical analysis and the means of obtaining it comes the molding of semi-steel shells. So many rejections and so much trouble could be traced to the use of green sand that its employment has been practically prohibited. The formation of gas and blow holes resulting from the action of the hot metal on the damp sand, and the sand cut from the mold and carried into the shell produced such wholesale rejections that the dry-sand mold became a necessity. One report, in particular, states that one foundry situated in northern France failed to produce a single satisfactory heat until green sand molding was abandoned. The character and grade of the sand and the method of molding varied according to the size of the shell made, and according to the equipment and familiarity of each individual foundry. Two requirements only seemed to be in common. *First,* the sand used and the binder and form of venting were such that the mold was absolutely free venting and porous, and *second,* every mold was provided with some form of trap gate to serve the double purpose of trapping any slag or dirt in the metal and removing air or gas that may be trapped in the metal.

Too much attention can not be paid to the use of the trap gate in molding with semi-steel, especially when the product is shells. A large number of foundrymen look upon it as one of those newfangled ideas to assist incompetent molders. They believe they are fully capable of keeping dirt and slag from entering the mold without such a gate. Such may be the case, but the molder does not exist who can pour a swift rush of semi-steel with the speed necessary to produce perfect shells without trapping air and carrying it into the mold. Ordinarily this air is free to escape through the porous sand, but often the first splash of the metal forms a thin skin or shell which seals the air in and results in the formation of the small holes familiarly known as gas holes.

Vertical Molding Discontinued

The position of the casting when poured was a point that gave considerable trouble when the French foundries first started on semi-steel shells. It was at first considered necessary to pour the casting on end, either point or base up, and to allow extra metal on the cope to collect dirt or gas holes and to provide metal for possible shrinkage. This form of molding, while satisfactory in so far as the quality of the shell was concerned, had two disadvantages. It necessitated extra machining to remove the excess metal and it was a difficult molding operation. As the various operations were reduced to a scientific basis, it was noted that the extra metal was no longer a necessity, and a great many foundries discontinued the vertical form of molding. This enabled them to use the match plate form of machine molding and to mold the shells in pairs, using a balanced core.

In order to obtain a record of the grade of the metal during the course of the heat, practically all of the foundries at first adopted the method of casting test pieces at various times during the heat. These test pieces were examined in various ways and the results compared to the mixture, or to he method of operation which had been used at the time the metal represented by the test piece was charged. Some adopted the plan of casting against a chill, breaking the piece and observing the depth of the chill. While satisfactory to a degree, there was one serious objection to this method. The depth of the chill is determined by two factors, the chemical analysis and the temperature of the metal at the time it strikes the chill; it was difficult to determine which might be responsible for an error in the depth of the chill. A ladle of iron or semi-steel of a given chemical analysis may be productive of a series of depths of chills which vary according to the temperature of the metal when poured. The depth of the chill is greatest when the metal is at the highest temperature and if poured at a very low temperature, where the metal is becoming mushy, the chill can be reduced to a mere skin. This fact resulted in the production of test pieces of varying depths of chill which did not vary chemically to a corresponding degree, when the unchilled portion was analyzed. This resulted in confusion and uncertainty as to the accuracy of the tests. Other foundries ground a spot on the test piece and used the scleroscope for the test, while others resorted direct to chemical analysis.

Any method of examination, however, proved of little value, except as a matter of record for future reference, for the particular portion of the heat represented by the test piece was already melted, and any change made in the mixture in an effort to correct the analysis did not affect the metal until some eight or 10 charges later when, in all probability, it was not needed. When the form of investigation depended upon the scleroscope or the chemical analysis this discrepancy in time was increased by the time necessary to prepare the piece and make the determination. For this reason any attempt to use the test pieces for the purpose of enabling the foundryman to make a correction during the heat was abandoned, and if the casting of test pieces was continued at all it was only as a matter of record.

The cleaning of the shells is a matter that may be left to the individual foundryman, although the most satisfactory method in France seems to be tumbling and pickling in a hydroflouric acid solution. The tumbling serves to remove the sand adhering to the surface and to knock or rattle out the core, while the acid bath following insures practically a naked iron which facilitates machining. Sand particles are eaten out and spongy spots or porous areas, that are frequently not easily detected after tumbling alone, are exposed.

Too much attention cannot be paid to the inspection of the product. It should be severe and thorough. Every piece passed should have been inspected not only for soundness and size, but for weight, strength and texture. The scleroscope should be used on several spots on each piece and the shell should be subjected to a hydraulic test to develop any holes or strains. A rigid inspection before the casting leaves the foundry will save many hours useless labor on shells which develop defects during machining or which fail to pass the ballistic test. The economy effected is sufficient to warrant the utmost care and thought.

The story of the difficulties encountered and the financial losses incurred, due to ignorance of the requirements, when our various industrial establishments first undertook to make foreign munitions, is familiar to all. So with the experience of the French foundries to guide, bearing in mind the lessons from many munition failures in America, our own foundries should be prepared to do their part, should, by any chance, the swiftly changing current of events necessitate a call upon them.

Castings With a White Core

By W. J. Keep

Question:—We are experiencing difficulty resulting from the chilling of small castings, a sample of which has gone forward under separate cover. It will be noted that the center of the casting is chilled, whereas a gray exterior surrounds this chilled portion. One man pours off 180 molds of these castings per day, or 2,160 pieces. We find about 50 to 100 of these castings showing this peculiarity in a day's work from some of the floors. As tapped from the spout, our iron contains 3.05 per cent silicon and 0.099 to 0.107 per cent sulphur. Our charges consist of 400 pounds of new iron, 600 pounds of remelt, and 100 pounds of coke. We melt at a blast pressure of from five to seven ounces. In breaking up the pig iron we occasionally find some chilled fracture. Our iron runs in a continuous stream and is carried away in hand ladles as fast as melted.

Answer:—The fault is not in your iron. The first iron falls on a damp cupola bottom, at least it boils because of either the steam or gas from the cupola bottom. The first iron is caught in a ladle that has not been used before and the iron boils again. If this is poured into another ladle to dry it, and it boils again, it will probably produce castings gray on the outside and white in the center. The first 300 pounds of iron should be used in drying ladles and poured into the pig bed or into castings. If the molder will catch the first iron and pour it into his mold, hard spots will not occur.

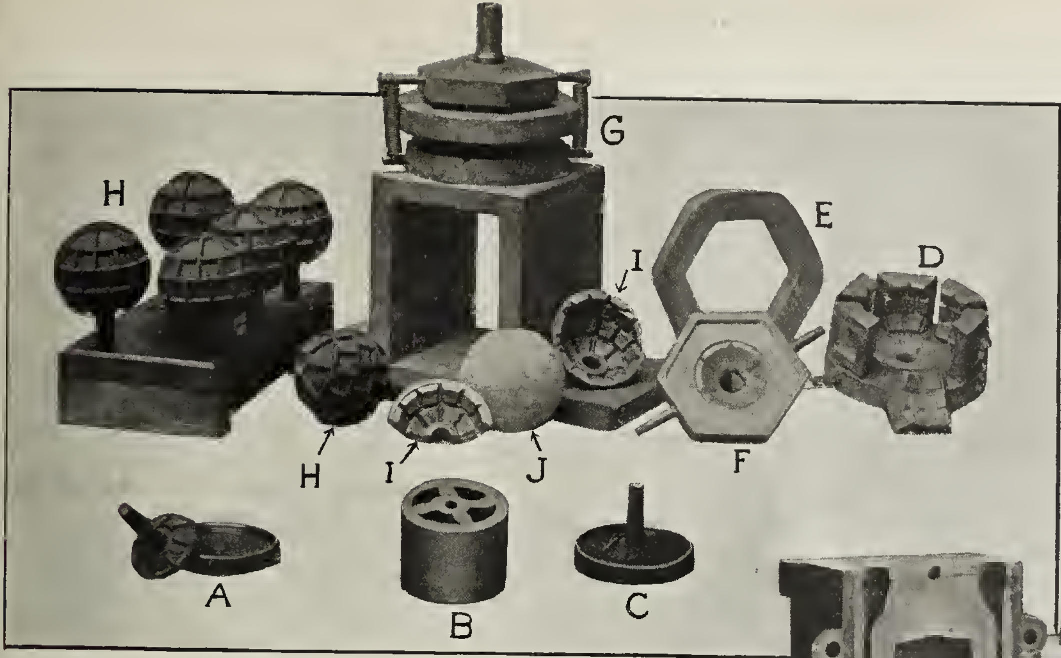

Fig. 1—Cores and Core Boxes for French Grenades

Molding Shells and Grenades for the French Army

TO PERSONS who have not had actual experience in a country where every effort is centered upon ultimate victory on the battle front, the important part played by the modern foundry in creating implements of war is only vaguely realized. In France, foundries have been diverted from peaceful pursuits to a basis of war business in a comparatively short time and the efficiency which has been developed is remarkable..

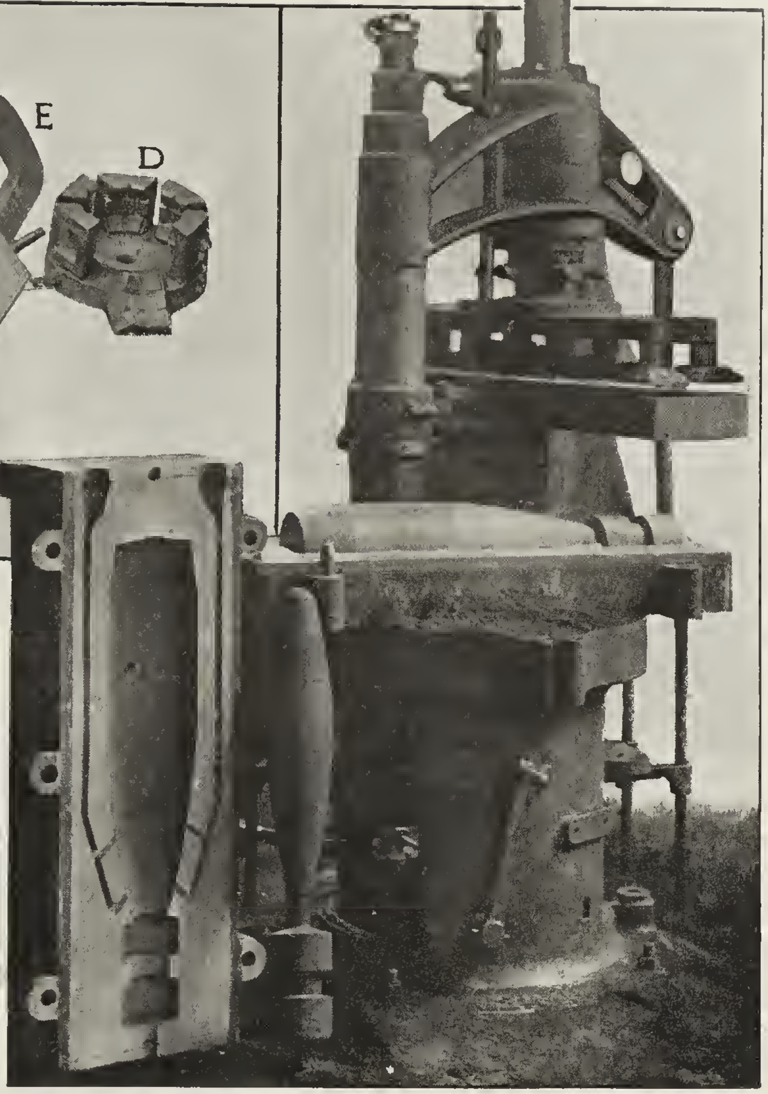

FIG. 3—HYDRAULIC MOLDING MACHINE FOR 155-MILLIMETER SEMI-STEEL SHELLS

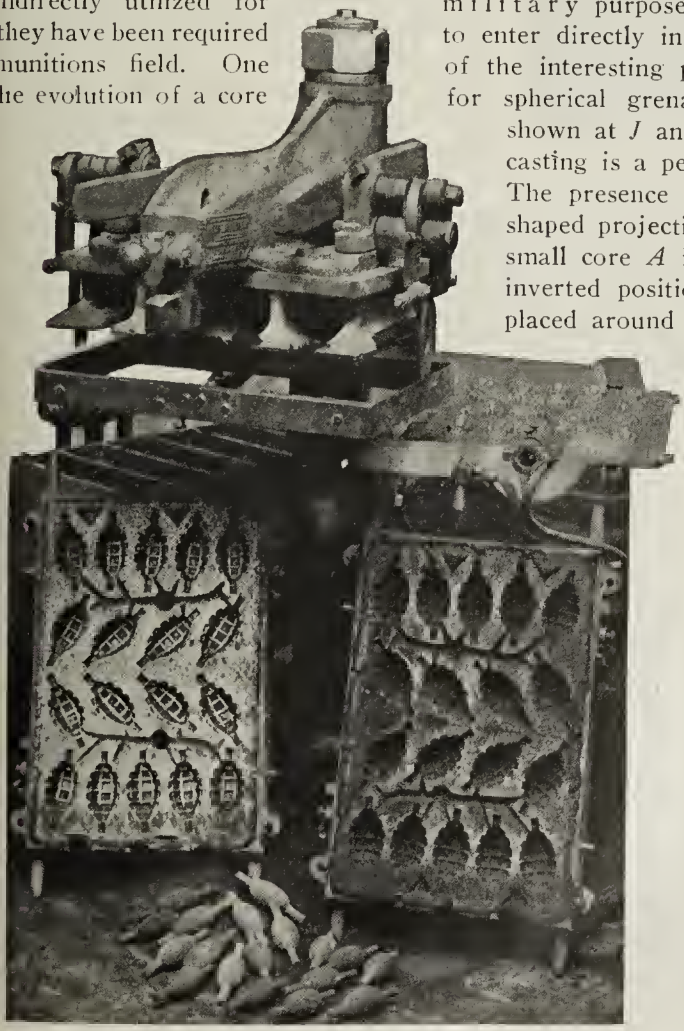

FIG. 2—HYDRAULIC MOLDING MACHINE FOR HAND GRENADES

Not only have the French foundries been called upon to furnish a great variety of castings for various machines indirectly utilized for military purposes, but they have been required to enter directly into the munitions field. One of the interesting phases of this new work is the making of grenades. Fig. 1 shows the evolution of a core for spherical grenades used by the French armies. A complete grenade casting is shown at *J* and sectional parts of grenades are shown at *I, I*. The exterior of the casting is a perfect sphere, while the interior is marked by deep staggered grooves. The presence of these grooves involves the use of a spherical core having web-shaped projections on the outer surface. *B* is the core box, in which the lower or small core *A* is made. In building up the entire core, the part *A* is placed in an inverted position in the bottom section of the core box *D*. The band *E* is then placed around the six side sections of the core box and the sand is placed in the box. After it has been rammed, the top section of the box, *F*, is put in place and additional sand is applied through the hole in the top. The springs shown in *G* are then applied to hold the drag and cope tight to the cheek and additional sand is added through the hole in the top. After the sand is rammed, a plug is inserted in the hole and the ring may then be taken from the cheek so that the six sides may be expanded to allow the core to be removed. The finished cores in position for baking are shown at *H, H*.

Another form of grenade is made on the hydraulic molding machine shown in Fig. 2. Machines of this kind are designed for flat work, two flasks being rammed at the same time. White-metal or cast-iron match plates are used. The flasks are barred and can be poured either in a horizontal or vertical position. Molds can be made on these machines in from one to two minutes, according to the difficulty of the work. The molds shown in Fig. 2 are for small hand grenades used by the French. It will be noticed that the mold has been arranged to be poured in a horizontal position, two pouring gates being provided in the cope. Each mold will make 18 grenade castings. These grenades differ from the one shown at *J* in Fig. 1, in that the exterior surface is webbed and the interior is smooth. This simplified the coring and plain eliptical cores having axial core prints as shown in the foreground of Fig. 2, are used. Figs. 3 and 4 illustrates a type of hydraulic molding machine used extensively in

France for molding semi-steel shells. Fig. 3 shows a mold for a 155-millimeter shell. One casting is made in each flask and the mold is split in half, each part containing half of the pouring gates, runners and core prints. The core shown at the right is supported in the mold by means of core prints as the bottom and chaplets at the sides. After the flask is set in the vertical position for pouring, the chaplets may be drawn out, leaving the core entirely supported by the core prints. The hydraulically operated molding machine shown in Fig. 3 is capable of making from 15 to 20 shell molds per hour.

The mold for two 90-millimeter semi-steel shells is shown in Fig. 4. The method of molding and pouring these molds is similar to that used in the case of the 155-millimeter shells except that a single gate and runner delivers metal to both molds. The output of the smaller shells on a hydraulic machine is from 15 to 20 molds per hour.

The use of hydraulic pressure for molding machines in France was given a marked impetus by the great demand for war materials. It is claimed that the hydraulic machines operate with a steady motion and that high pressure may be secured and controlled with comparative ease. The pressure for the average molding machine varies from 750 to 1,500 pounds per square inch, enabling the designer to keep the diameter of the rams to a reasonable limit and yet attain an adequate total pressure. This has permitted the design of large machines with a static pressure of as high as 80 tons. Small pipe of from ½ to ⅞-inch inside diameter is of sufficient strength and size for all piping used in connection with these machines.

Most French companies have found that it is more economical to use strong and uneducated laborers on molding machines than to employ molders who have a better knowledge of foundry practice. Since the war many women have been working on molding machines and they do exceedingly good work, especially on light and medium-sized molds. Piecework is preferred as the basis of payment in many French foundries, but there are a number of employers who favor the premium system of payment. Men who prefer the latter system feel that the piecework price, when once set, is a source of difficulty with the men. With the premium system, they claim, these difficulties may be more easily adjusted. Advocates of the piecework system, however, contend that if an equitable piecework price is determined after sufficient study of all conditions entering into this price, no trouble is experienced and the piecework method of payment tends to increase production.

British Institute of Metals Meets

Interesting discussions of subjects pertaining to the melting of metal featured the annual general meeting of the Institute of Metals in the lecture hall of the Chemical Society, London, March 21 and 22, 1917. Among the important papers presented in abstract at the two sessions of the meeting were articles on the "General Properties of Stamping and Chill Castings in Brass" and "Machining Properties of Brass", by Owen W. Ellis, London; "Surface Tension and Cohesion in Metals and Alloys", by Sydney W. Smith, London; "Aluminum Production by Electrolysis", by R. Seligman, London, and "Annealing of Nickel Silver", by F. C. Thompson, Sheffield.

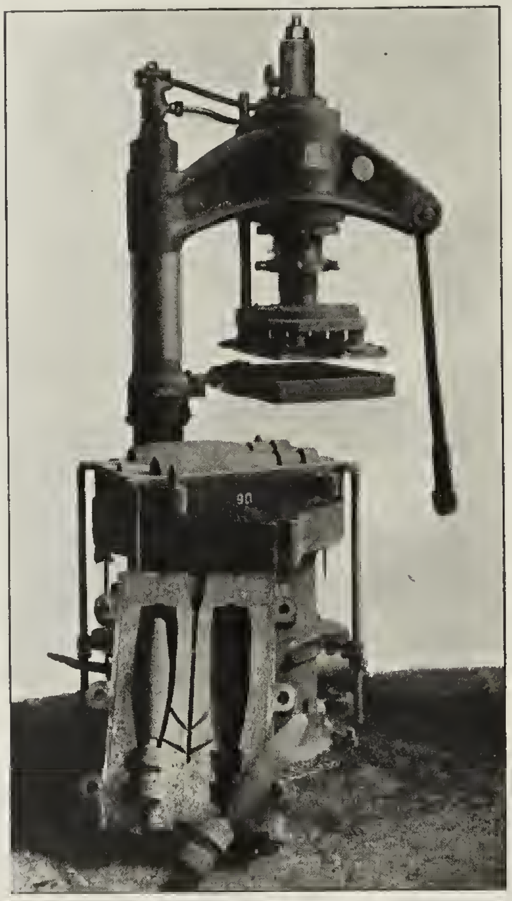

FIG. 4—HYDRAULIC MOLDING MACHINE FOR 90-MILLIMETER SEMI-STEEL SHELLS

In the discussion of metal melting, W. J. Hocking, London, reviewed a paper describing the process employed in molding metal at the royal mint. G. B. Brook, Sheffield, discussed coal gas as a fuel for melting non-ferrous alloys, and C. M. Walter, Birmingham, spoke on high pressure gas melting. H. C. Greenwood, London, and R. S. Hutton, Sheffield, contributed a paper on "An Electric Resistance Furnace for Melting in Crucibles". Other discussions were contributed by H. M. Thornton, H. Hartley, Carl Hering and H. S. Primrose.

In the general discussion considerable attention was given to fuel economy in the operation of melting furnaces. The importance of the subject, which apparently has been brought to the attention of foundrymen by the unusual requirements of metal for munitions making in England, was particularly emphasized in a number of the papers read. It was shown that the lack of comparative data had been responsible, in many cases, for failure to adopt efficient means of metal melting. The meeting was in charge of Sir George Beilby, head of the new government board of fuel research.

Determining Proper Weight of the Coke Bed

By W. J. Keep

Question: — Our cupola is lined to 45 inches, and the distance from the bottom of the furnace to the bottom of the tuyere openings is 15 inches. It is provided with six sets of tuyeres, each having three openings, 5 inches high and 5 inches long, making a total outlet area of 435 square inches. We charge 3,500 pounds of iron and 1,450 pounds of coke on the first charge and 3,000 pounds of iron and 280 pounds of coke on the succeeding charges, and are obtaining satisfactory results. However, we have been informed that the coke beds should be from 20 to 24 inches deep after it is burned down. Assuming that the 20 to 24-inch height should be above the tuyeres instead of above the bottom, I would still have 18 to 22 inches too much coke on the bed. Prior to my employment in this foundry, it was the practice to charge 2,500 pounds of iron, but with the same amount of coke as indicated. However, we gradually increased the iron charges with the result that the good casting ratio increased above what we had formerly with the higher fuel melting ratio. We would like to know whether we are getting all that we have a right to expect and we would like to know whether the advice we have had regarding the height of the coke bed is correct.

Answer: — Everything that you have done seems to be right. I assume that you have only one row of tuyeres in six groups each, having three openings, or practically six tuyeres, each 5 x 15 inches. If this is so, you should reduce the bed 25 pounds each day until you have reached a point where this reduction is sufficient. In my practice I endeavor to have the coke extend 15 to 18 inches above the top of the tuyeres when the iron is about to be charged. It would be advisable to slag the cupola, as this will improve the results. However, it is advisable to go slow in making changes, since the results outlined by you seem to be unusually satisfactory.

New Converter Plant for Economical Operation

Novel Method of Handling Metal in Cupola, Converter and Ladle Reduces Amount of Equipment Required—Cleaning Room Facilities Unusually Complete

I WISH I had a dollar for every statement I have heard to the effect that "all foundries are the same". Talk with almost any foundryman and he will tell you that a particular casting plant "is just like all the others".

The last man to reveal this remarkable fact to me was Tom Marshall, beaming salesman of the United Foundry Equipment Co. When he learned that I was going to Springfield, O., to secure a description of the new converter foundry of the Blackwood Steel Foundry Co., he assembled all of the cynical sagacity of his 20 years in the foundry equipment business in an effort to prove to me that Blackwood's plant was no different from the many other converter foundries in the country.

"What are you going to write about the place?" he demanded. "I've seen Blackwood's establishment, and believe me, he has a good line of equipment and knows the business, but his shop looks like all the others. All you can say is that he has a new plant, that each building is so many hundred feet long and so many feet wide, that the melting equipment consists of so and so, and that the cleaning apparatus was installed by Smith, Jones & Co. As far as I can see, all you can possibly do is to write the same old story. Why don't you describe a plant where there is something new to talk about?"

Editor's Note

Personal impressions are always interesting. Conventional plant descriptions, on the other hand, are prone to be as dry as dust. The accompanying article presents in a frank, personal way the essential features of the organization, equipment and methods of the Blackwood steel foundry. The editor believes this method of treatment will commend itself to the readers of The Foundry. It's the next best thing to taking a stroll through the shop yourself.

Not having seen the Blackwood foundry I could not bring forth tangible proof that it was "different", but I carefully assured Marshall that I would surely find something unusual in the Springfield casting plant.

"Oh, that's all right to say. The optimism of the cub is still at high tide in your veins. You'll get over that. I suppose you will come back with the same dyed-in-the-wool yarn that every trade journal has been using in the last 20 years in describing new plants and their equipment."

With this parting shot, he left me pondering over the question his frank remarks had aroused. Are or are not all foundries alike?

* * *

After a brief survey of the various departments of the Blackwood foundry I had the feeling that possibly Marshall was more nearly right in his contention than I. As he had said, to all outward appearances there were few marks to distinguish the plant from any of the many converter foundries in the country. The only noticeable feature that I observed was that the cleaning room equipment was unusually complete. In fact, I could recall only one or two foundries in which the sandblast apparatus accommodated the large range of castings handled by this equipment in the Blackwood plant.

Satisfied that in the main, the equipment was not of sufficient novelty to warrant a lengthy description I turned my attention to the methods of operating the foundry, and here I found the features which distinguish this steel foundry from all others. In reading the following account of what I learned at Springfield, the reader will realize that every plant has its individual characteristics. Two plants with identical equipment throughout

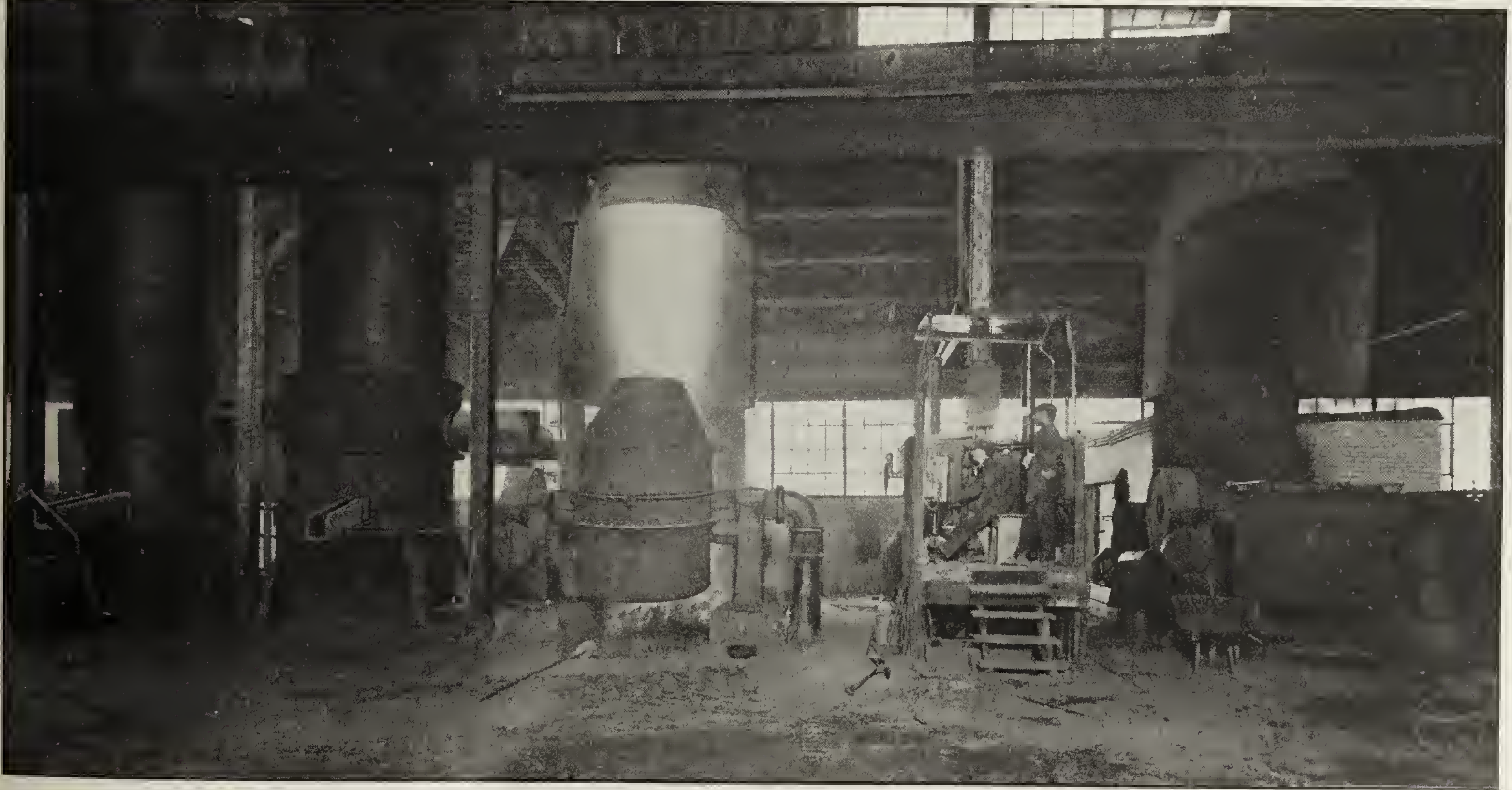

FIG. 1—ARRANGEMENT OF MELTING EQUIPMENT—THE MANNER IN WHICH THE DESIGN OF THE TWO-PIECE CONVERTER FACILITATES RELINING IS INDICATED AT THE RIGHT

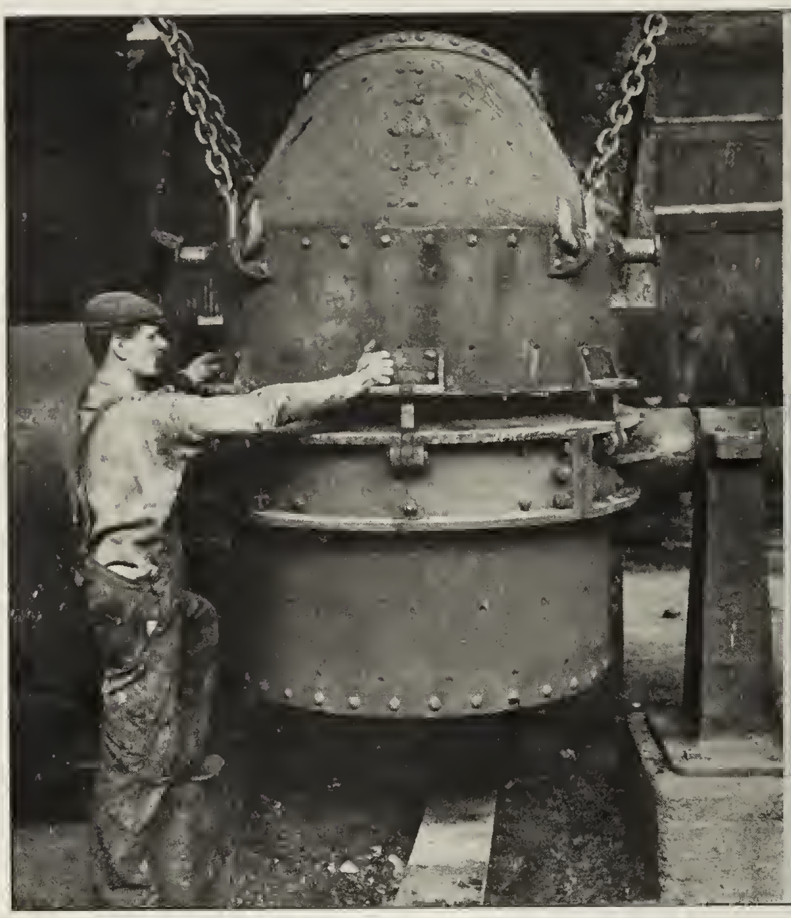

FIG. 2—SHOWING HOW TWO-PIECE CONVERTER IS PARTED ABOVE TRUNNIONS

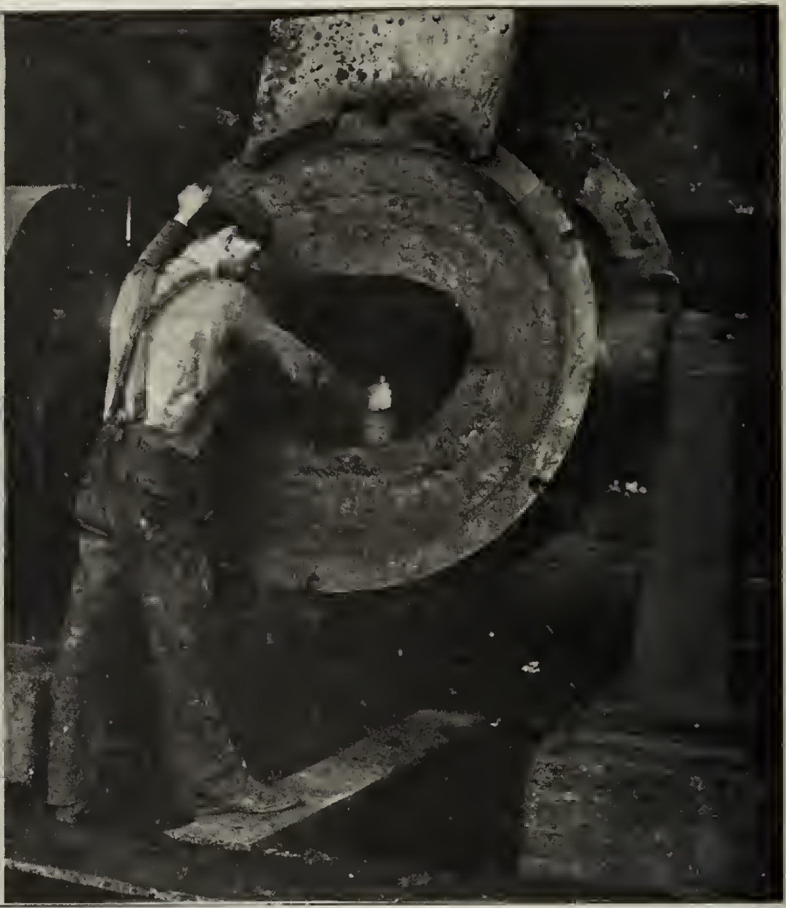

FIG. 3—REPAIRS TO LINING ARE SIMPLIFIED BY TWO-PIECE CONSTRUCTION

every department may be similar physically, but as long as they are under separate managements, different ideas of operation will be reflected by the methods employed in making castings. And that is the reason that there is a "story" in every foundry.

Making Converter Steel

The steelmaking process at the Blackwood foundry is interesting. The melting equipment is composed of two specially designed cupolas of the blast furnace type and two 2-ton side-blow Tropenas converters of the Blackwood two-piece type. The cupolas which are 36 and 56 inches inside diameter, respectively, are charged with a mixture of approximately 65 per cent scrap and 35 per cent pig iron. Thirty per cent of the scrap is made up of the risers, heads, etc., from the cleaning room, and the remainder is a high grade of shell discards. The cupola is operated so that approximately 8 tons of metal are always in the process of being melted, this amount being sufficient for four 2-ton charges for the converter. A blower made by the P. H. & F. M. Roots Co., Connersville, is connected in series to the cupolas, and may supply the blast to either or both as desired.

A full charge of metal is tapped from the cupola into a 3-ton ladle handled by a 5-ton electric traveling crane built by the Toledo Bridge & Crane Co., Toledo, O. After the metal is blown it is poured into distributing ladles and delivered to the molds by hand.

The efficiency of the melting equipment is greatly increased by the special design of the cupolas and converters and by the system of operation. By constantly maintaining a sufficient amount of metal in the cupola to provide for four blows of the converter, the heating value of the coke is considerably increased, enabling the use of a one-to-seven ratio of fuel to iron.

Advantage of Two-Piece Converter

The two-piece arrangement of the converters greatly facilitates relining and permits the use of one converter continuously for a full day while the other is being relined. As shown in Fig. 2, the two-piece converter is similar in all respects to the ordinary bessemer unit except that the shell is in two parts, the line of division being a ring just above the trunnions. This arrangement makes it possible to remove the upper part

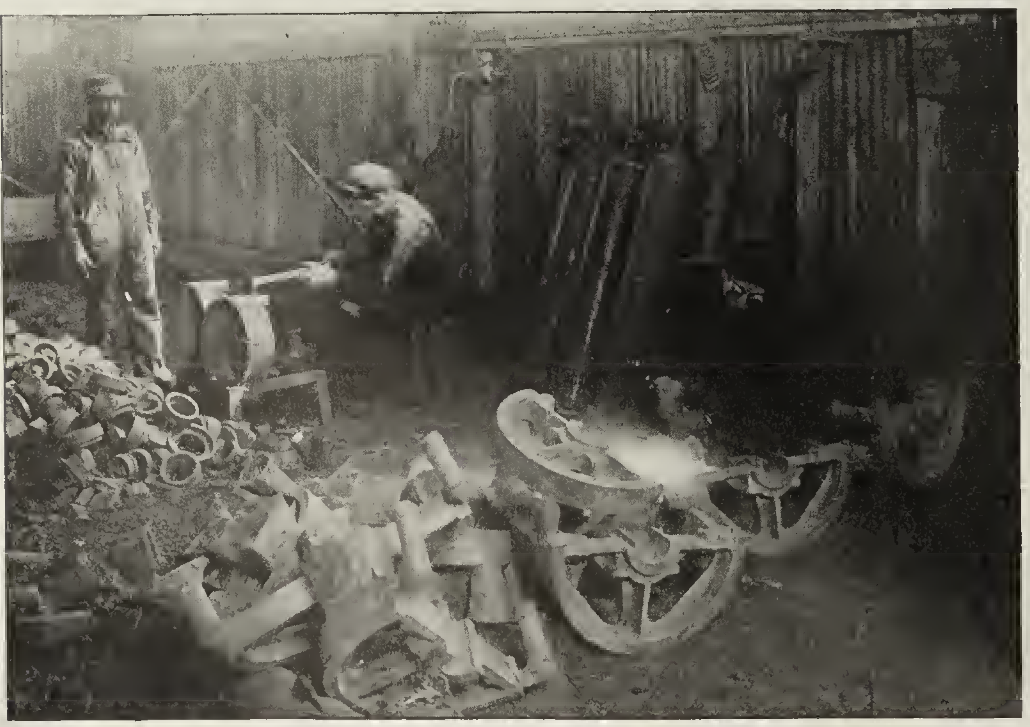

FIG. 4—SPRUES, GATES AND RISERS ARE REMOVED BY MEANS OF ACETYLENE CUTTING TORCHES

of the shell from the lower half, thus making the interior of both sections accessible for relining. A detailed description of the two-piece converter, which is an improved type of the Tropenas unit patented by A. F. S. Blackwood, appeared in the February, 1913, issue of *The Foundry.* At the present time from 20 to 22 blows are taken from the converter each day.

As I watched the workmen in the act of carrying hot metal from the tilted converter to the molds in small hand ladles I was again reminded of the "all the same" arguments of my friend Marshall. Here, evidently, the method of distributing metal employed in the typical foundry was being followed to the letter. Just as I was about to dismiss the pouring process as an impossible feature for my story my attention was called to a couple of brackets riveted to one of the building columns. As their purpose was being outlined to me, I had visions of again upholding my contention with the salesman, for the brackets are the forerunners of a system of metal distribution that will mean a remarkable saving in time, labor and equipment.

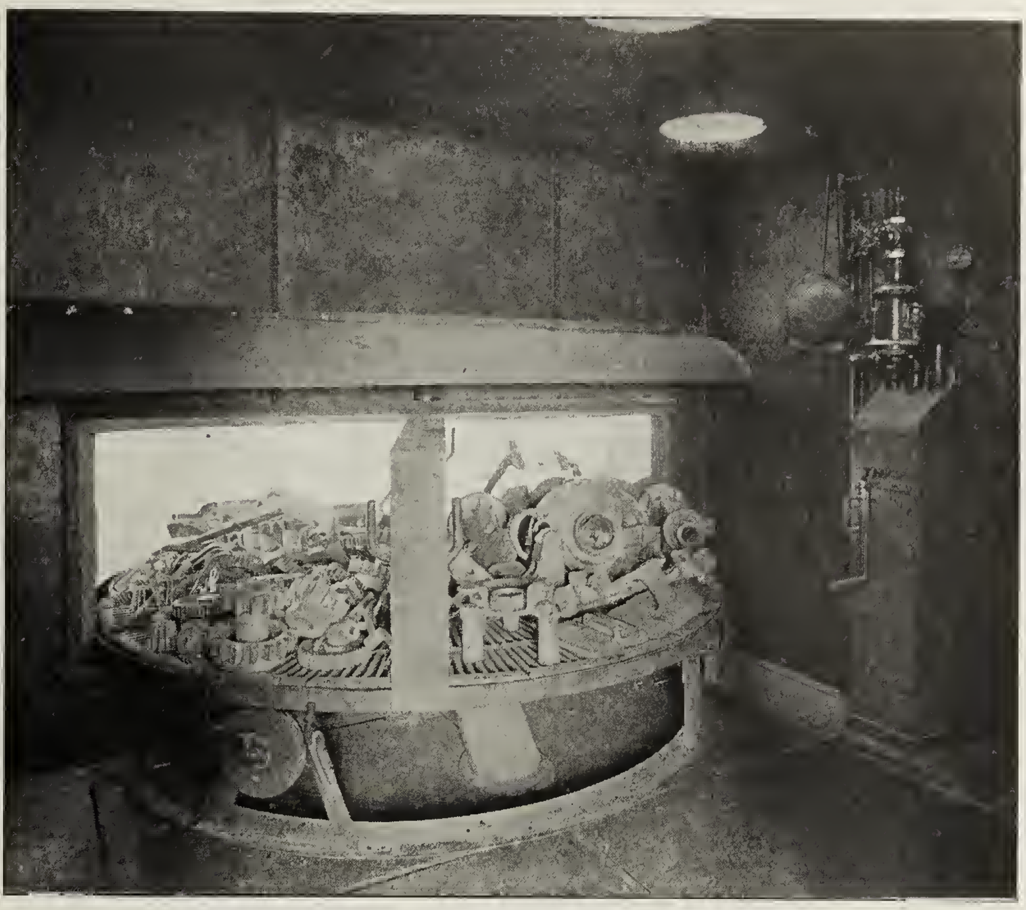

FIG. 6—UNUSUAL VIEW OF INTERIOR OF ROTARY TABLE SAND BLAST CHAMBER

A Unique Pouring System

Under the present system of pouring, the converter is merely a ladle during the time the metal is being carried from it to the molds. When the four heavy brackets situated at convenient points in the foundry are installed, the entire blow from the converter will be poured into a large tea-pot ladle carried on the hook of the 5-ton crane. This ladle will be carried to one of the four brackets, which is at the proper height from the floor to bring the spout at a point convenient for pouring into the small distributing ladles. This arrangement will enable the converter to empty its charge in less than a minute. The slag can be run out, a new charge deposited from the cupola, and under favorable conditions, the bessemer unit be placed in position for blowing five minutes after the last melt has been discharged. Experienced foundrymen will have already concluded that this method also releases the crane for other duties as soon as the tea-pot ladle is placed on one of the brackets.

Heating Relined Ladles

This plan naturally necessitates the use of a larger number of ladles, and in order to facilitate their heating an ingenious apparatus has been devised. Cast frames about 5 feet square are held in a vertical position and lined with fire brick. A hole of sufficient size to allow the entrance of

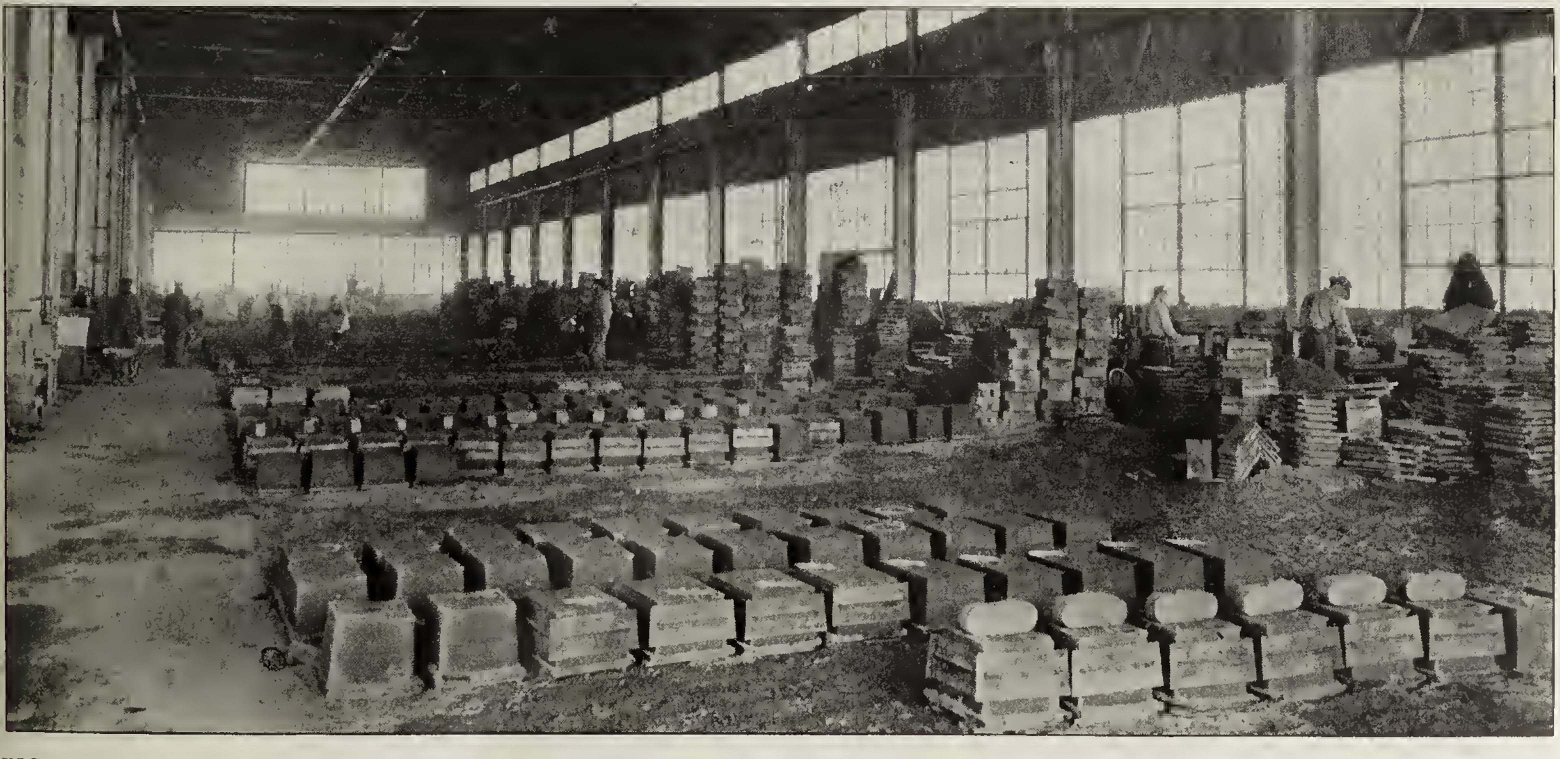

FIG. 5—VIEW OF THE MOLDING FLOOR—THE SMALLER MOLDS IN THE FOREGROUND ARE MADE ON SQUEEZERS AND THE LARGER ONES AT THE END OF THE BUILDING ARE MADE ON ROLL-OVER JAR-RAMMING MACHINES

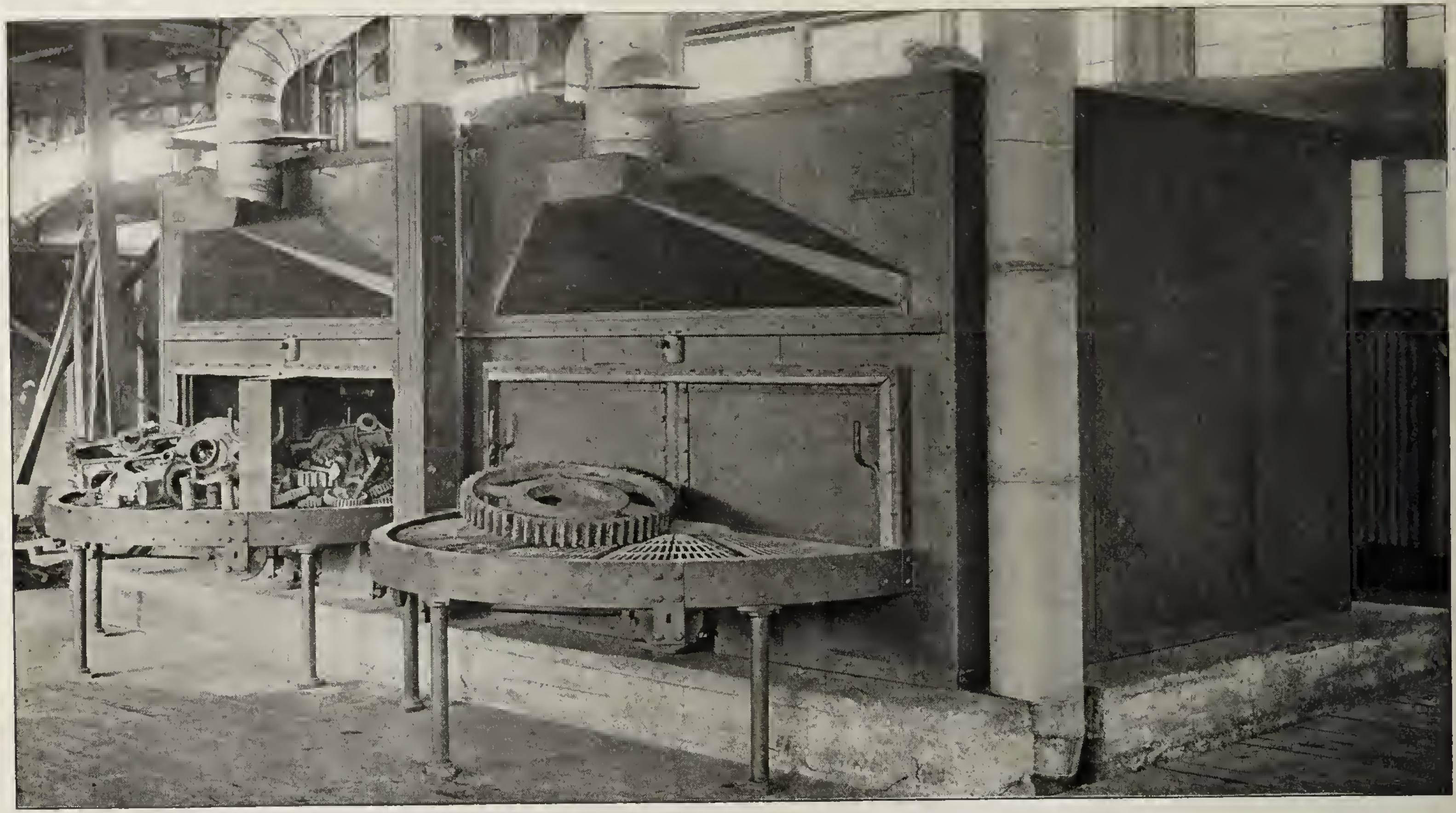

FIG. 7—CASTINGS TOO LARGE FOR THE SAND BLAST BARREL ARE CLEANED ON THIS ROTARY TABLE MACHINE—UNUSUALLY LARGE CASTINGS ARE CLEANED IN A SAND BLAST CHAMBER

the flame from an oil torch is left in the center, and a torch with oil and air connections is fastened to the back of the vertical frame. The ladle to be heated is placed in front of the frame with the edges tight against the fire brick. When the torch is lighted, the flame is directed against the bottom of the ladle, and since the fire brick in the frame makes the ladle an enclosed chamber, practically all of the heat is expended in heating the lining.

Molding sand is handled in an unusual manner. Castings are shaken from the molds as soon as possible after they are poured. The old sand is cut over by a sand mixing machine built by the Sand Mixing Machine Co., New York, and the excess which is not used for backing is carried to a dry pan made by the Frost Mfg. Co., Galesburg, Ill., in trucks furnished by the Lakewood Engineering Co., Cleveland, drawn by a storage battery tractor built by the Automatic Transportation Co., Buffalo, N. Y. The sand is carried from the molding floor to the dry pan at night, and this allows time for the tractor batteries to be charged during the day while the tractor is not in use. Facing sand is made up from three parts of new to eight parts of floor sand, and calculated on a monthly basis for molding and core sand, the ratio of new sand to old is approximately one to six. The sand is sifted through gyratory riddles made by the Great Western Mfg. Co., Leavenworth, Kan., and is rammed by pneumatic rammers manufactured by the Chicago Pneumatic Tool Co., Chicago. Compressed air is furnished by an Ingersoll-Rand compressor situated in a small building which houses a Westinghouse motor-generator set, together with transforming apparatus,

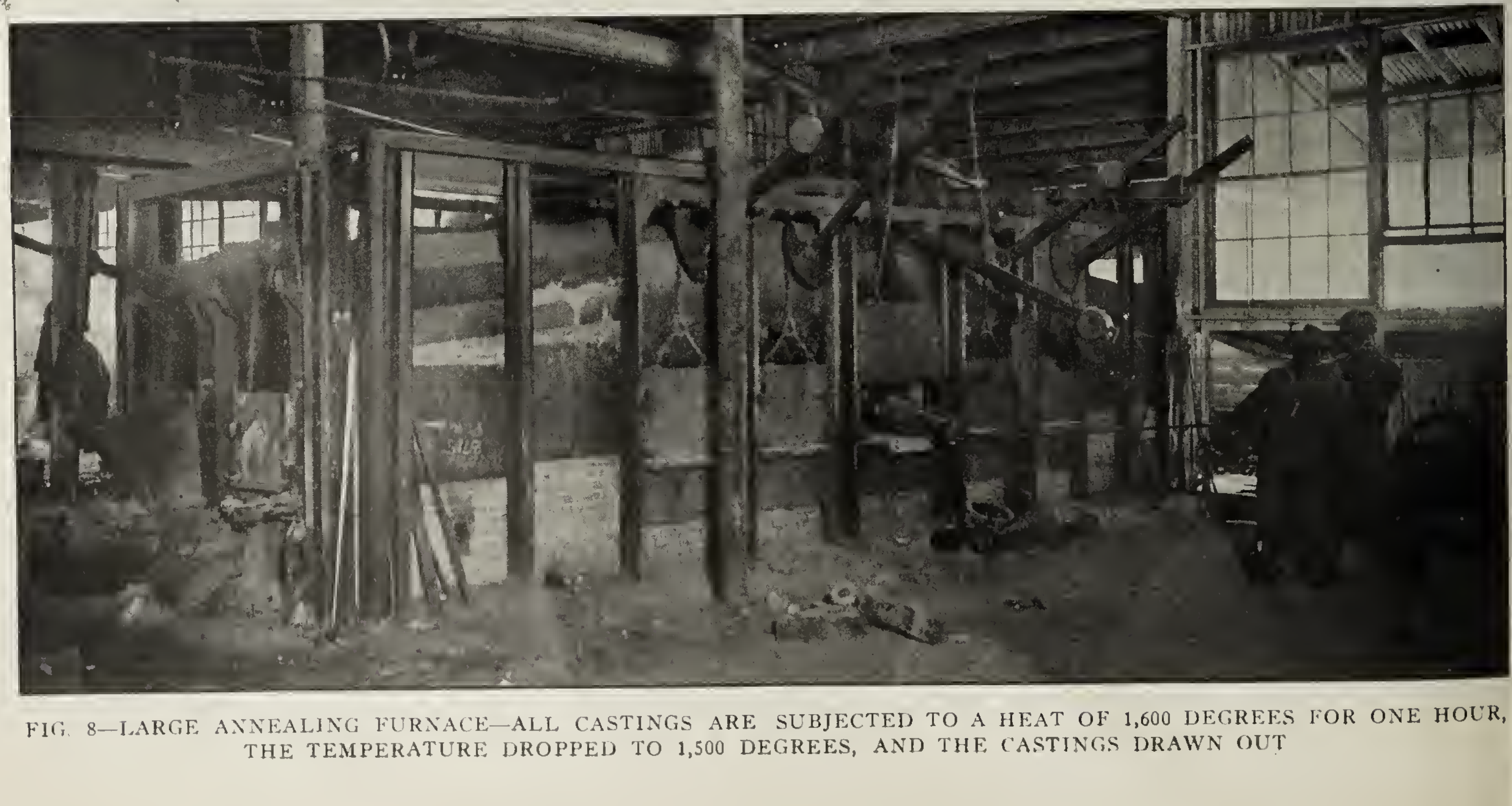

FIG. 8—LARGE ANNEALING FURNACE—ALL CASTINGS ARE SUBJECTED TO A HEAT OF 1,600 DEGREES FOR ONE HOUR, THE TEMPERATURE DROPPED TO 1,500 DEGREES, AND THE CASTINGS DRAWN OUT

switchboard, and the usual accessories.

Small-sized castings are molded on a battery of 18 roll-over and pattern-draw squeezers built by A. Buch's Sons Co., Elizabethtown, Pa., and the larger molds are made on two combination jar-ramming turn-over power-draft machines manufactured by the International Molding Machine Co., Chicago, and a similar machine built by the Tabor Mfg. Co., Philadelphia. Two smaller roll-over, jar-ramming machines manufactured by each of the two last named companies are used in the core room. The molds are dried by oil torches made by the Hauck Mfg. Co., Brooklyn, N. Y., and the Mahr Mfg. Co., Minneapolis, Minn.

Small cores are made in a Hammer core machine built by the Brown Specialty Machinery Co., Chicago, while the large ones are made in core boxes by hand. Small cores are baked in two gas-fired Crawford sectional ovens built by the Oven Equipment & Mfg. Co., New Haven, Conn. A Connersville blower provides the blast for these ovens. Large cores are baked in a double-chamber, coke fired oven designed and built by the Blackwood company. Angle irons fastened on the interior walls of the oven at convenient heights form supports upon which the metal trays carrying the cores are placed.

Cleaning Room Operations

Every casting is shaken from the mold and carried to the cleaning room before the completion of the day's work in the foundry. The sequence of operations in the cleaning department is as follows: Sand-blasting; cutting off sprues, risers, gates, etc.; first inspection; electric welding; grinding; second inspection; annealing; tumbling; and third inspection. If the third inspection reveals defects that may be overcome by welding, the casting is sent back to the welding room, and from there it passes through all of the subsequent operations again.

The sand-blasting equipment consists of a large sand blast barrel furnished by the Brown Specialty Machinery Co., Chicago; a twin-chamber rotary-table sand-blast machine, shown in Figs. 6 and 7; and a sand-blast room. Dust from the sand-blasting equipment and from the grinders, tumblers, etc., is blown into dust arresters situated on elevated platforms about 30 feet from the cleaning room. One of the arresters, with accompanying flues from the cleaning room, is shown in Fig. 9. The rotary table machine, sand-blast room, and arresters were manufactured and installed by the Pangborn Corporation, Hagerstown, Md. The three types of sand-blast apparatus accommodate castings ranging in size from one ounce to more than 500 pounds. Small pieces are cleaned in the barrel; medium-sized castings are blasted in the rotary-table machine; and large and bulky castings are cleaned by means of a hand-operated sand-blast nozzle in the sand-blast room.

The castings are trimmed by means of a sprue cutter and acetylene cutting torches, and then, after being inspected, are sent to the welding department for attention. The electric arc-welding apparatus which was manufactured and installed by the Lincoln Electric Co., Cleveland, is enclosed in a room next to the sand-blast apparatus. Blow holes, shrinkage cracks and misruns are repaired by this electric process, after which the rough surfaces of the castings are ground. The grinding equipment consists of six two-wheel floor grinders made by the Safety Emery Wheel Co., Springfield, O., and four swing grinders designed by the Blackwood company. The swing grinders are unusual in that no babbitt is used in their construction, all bearings being of the roller type. The second inspection follows the grinding operation.

All castings are annealed in a large coal-fired annealing furnace built according to a design worked out by the George J. Hagan Co., Pittsburgh. A charge of castings is left in the furnace for a period of one hour at a temperature of 1,600 degrees, the temperature is then reduced to 1,500 degrees, and the castings are drawn from the furnace at this temperature. While still hot, they are placed in the three 72-inch exhaust tumblers made by the Whiting Foundry Equipment Co., Harvey, Ill. The annealing furnace temperature is indicated by a Brown electrical pyrometer made by the Brown Instrument Co., Philadelphia.

The Blackwood Steel Foundry Co. is an Ohio corporation capitalized at $400,000. The officers of the company are: A. F. S. Blackwood, president; J. E. Galvin, vice president and secretary; George S. Stage, treasurer. The product of the plant consists of a great variety of medium size castings, a large percentage of which are used in the automobile industry.

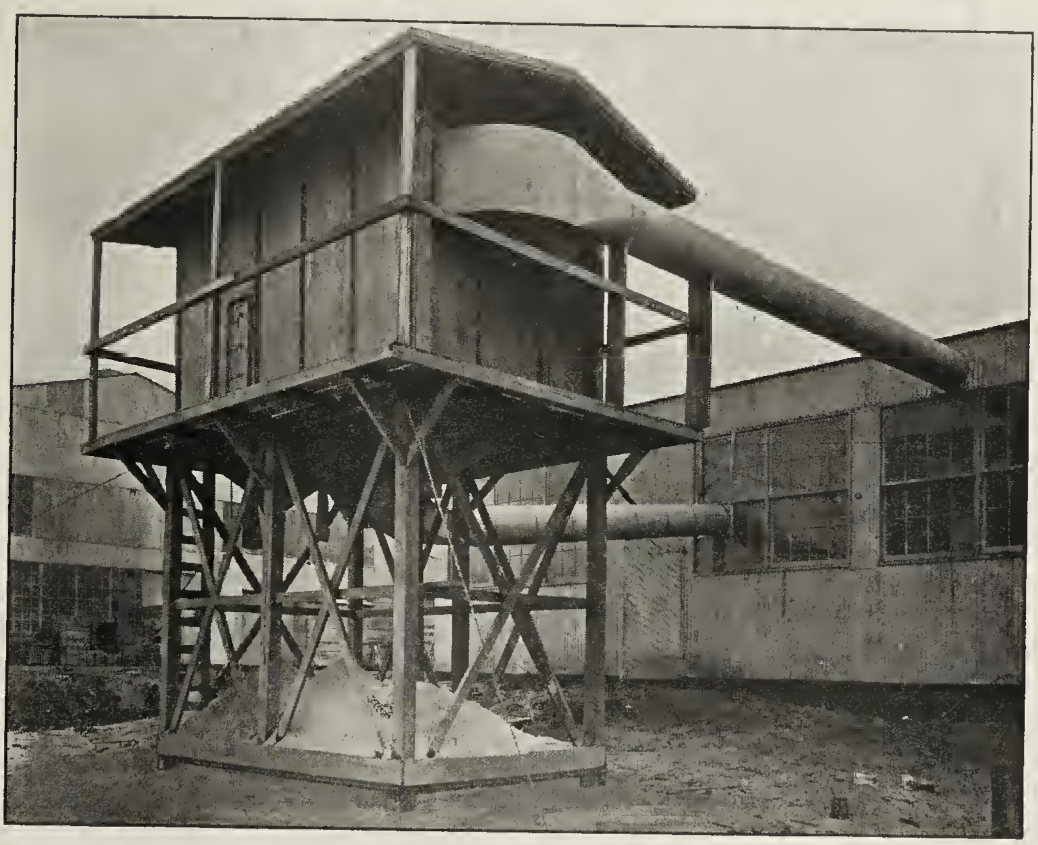

FIG. 9—DUST FROM THE SAND BLAST AND FROM THE TUMBLING BARRELS, GRINDERS, ETC., IS BLOWN TO DUST ARRESTERS OUTSIDE THE BUILDING

The annual sales convention of the branch managers and salesmen of the Independent Pneumatic Tool Co., Chicago, was held in that city on Feb. 28 and March 1. The first day's meeting was held at the company's factory, Aurora, Ill., where the representatives were given an opportunity to inspect the manufacture and construction of the company's extensive line of pneumatic tools. The second day's meeting was held in the New Southern hotel, Chicago, for the discussion of sales policies.

The Kirk Supply Co., Pittsburgh and Cleveland, has recently been appointed agent for the Canada Carbide Sales Co. A stock of carbide will be carried at Cleveland.

Protective Coatings: Japans and Enamels---II

By E P Later

IN THE preceding article the composition and properties of ordinary lacquers were briefly considered. Useful as these preparations are, however, there are many purposes, for example, finishing automobiles and general metal parts which must withstand wear and exposure and need to be protected from corrosion, for which they are not well fitted. Recourse must be had in such cases to certain other finishing materials which are of wholly different composition and possess different qualities, known as japans and enamels. These, and particularly the baking japans, give a hard, rugged film which has excellent protective as well as decorative qualities and are indispensable in certain classes of work.

In general, black baking japans are made by combining linseed oil and asphalt, gilsonite, stearine pitch, coal tar pitch and similar substances at high temperatures. The resulting product is thinned with turpentine, benzine, or light mineral oils and when properly applied and baked at temperatures ranging from 200 to 450 degrees Fahr. will give a more or less thick coating which is quite hard, fairly impervious to moisture and of a high luster. The baking period, which varies from two to six hours or longer, and the temperature of baking depend on the composition of the japan. Dull and medium gloss japans are made by grinding the bright japan with lamp black or carbon black in a fine mill, or by the proper selection of the materials.

Japans may be applied in any one of several ways such as brushing, dipping and spraying, depending on the conditions. Thus, by the first method, the japan is applied by brushing, as in painting and is employed on parts which, because of their size or for any other reason, cannot be dipped or sprayed.

In dipping, the parts are immersed in a large tank of the japan, which is thinned with a suitable solvent to the proper consistency for the purpose, and then hung on some sort of a rack and allowed to drip, the surplus japan running back into the tank.

Tumbling the parts, which must necessarily be small and of such shape as to permit of it in a barrel with a small quantity of the japan is a convenient way of applying the finish and may sometimes be used to advantage.

Spraying the Japan

Applying finishing materials by a spray produced by leading them into an atomizer and then vaporizing them by a current of compressed air, is one of the latest and best methods of finishing metal work in particular, although it is coming into wide use in other lines. It is not so cheap as tumbling or dipping, wherein a much larger number of parts may be coated at one time, but it is applicable in many instances where these do not give the quality of finish desired. Uniformity, smoothness of coat and ease of control of the thickness are its chief advantages and it is used on a large variety of high grade work.

After the application of the japan by one of the foregoing methods, the parts generally are allowed to air-dry for a short time, then are loaded on trucks or placed directly in the oven and baked; and right here it may be said that improper baking is a prolific source of trouble for many finishers. These materials vary all of the way from the air-drying sort, that is, those which will become sufficiently hard for the conditions of service by simple exposure to the air, to those which require heat-treatment to a temperature of 300 to 400 degrees Fahr. to oxidize and harden them. Therefore, there is a wide range of baking temperatures and it is important to see that the proper control of these is obtained, otherwise the results will not be satisfactory. A properly baked japan film should be hard enough to withstand scratching with the finger nail, but should not be so brittle that it will flake and chip off when cut through with a knife or struck sharply. If the film is not baked the way it should be, for instance, at too low a temperature or for too short a period, it will be too soft and tender and may even be sticky or tacky. On the other hand, overbaking, by overexposure to too high a temperature manifests itself in a brittle, lifeless film which chips easily and has poor adhering qualities.

The advice of the maker of the japan should be obtained as to the proper temperature and time of baking and ordinarily this should be followed closely, but it may be remarked that in general, an increase of temperature means a shorter time of baking, so a good deal may sometimes be done to shorten the finishing time by heating the oven hotter and thus decreasing the baking period. Such changes should be made cautiously, however, and only after careful experiments have shown the proper conditions to be maintained and that the finish so produced is fully up to the standard.

It is apparent that a good oven, heated throughout as evenly and uniformly as possible, and provided with the proper facilities for ventilation and accurate determination of the temperature, is a necessity if good work is to be turned out regularly. The baking of a japan film involves two distinct processes; first, driving off all solvents and compounds which are volatile at the temperature employed and second, oxidation of the oils and possibly other substances in the film to a hard coating which is insoluble and resistant to wear. If the vaporized gases and vapors are not given a free opportunity to escape they tend to hinder the baking and may result in poor or spoiled work.

There are several types of ovens, differing largely in the mode of heating, such as by steam, generally high pressure, electricity, gas and coke. Each has certain advantages and all are used to some extent, but the gas-fired ovens are very popular and find, perhaps, the widest use. Heating by means of steam coils is a convenient way of obtaining low to medium temperatures, but higher temperatures require the use of high pressure steam, which is harder both to produce and handle. If electricity is cheap it can be utilized satisfactorily for heating the oven, if the coils or heating units are properly planned and built; any temperature which would be required for the work can be produced and a close control maintained. The need of keeping a uniform temperature in all parts of the oven is a very real one, as otherwise some portions of the load will be overbaked and others not enough. In an electric oven the heating elements can be so placed as to eliminate this trouble almost, if not quite, entirely.

Heating the oven with coal or coke may be cheap enough, but it is rather unsatisfactory. Tending and regulating the fire involves a good deal of work, considerable time is needed to bring the oven up to the desired temperature and it is not an easy matter to keep it there, within reasonably close limits, and atmospheric conditions have much to do with the operation of the oven. Furthermore, the dust and ashes which cannot be completely done away with are detrimental to good work.

There are several well-designed gas ovens on the market and they afford a fairly cheap and convenient solution of the baking problem; they are arranged to give a good distribution of the heat, are easy to operate and permit of close control of the temperature at any desired point.

Repeated Coatings

After the parts have been baked and allowed to cool, those which are to receive more than one coat of japan are usually smoothed down and all roughness removed by means of fine sandpaper, after which all dust is carefully brushed or blown off and the second coat applied and baked as before, this process being repeated the requisite number of times. In some classes of work the final coat is rubbed with pumice stone in water or otherwise treated to produce a higher grade finish.

A large variety of household and other articles, shovels, dustpans, etc., are finished with a very cheap grade of apan made by dissolving bituminous compounds in turpentine, benzine or similar solvents. These japans usually are applied by dipping, are often airdrying, although some are baked, and give a glossy brown or black finish which serves the purpose for which it s intended and frequently stands up surprisingly well. They would not, of course, be suitable for very high grade work, but are mentioned here as the metal finisher sometimes may be called upon to use them.

For many purposes, however, the foregoing class of materials is not suitable, as white or almost any other color may be required, so recourse is had in such cases to those materials known as japan-enamels or varnish-enamels, to distinguish them from the true enamels which are essentially fusible glasses and will be considered later.

Varnish-Enamels

These varnish-enamels are produced by grinding one or more pigments in a suitable varnish vehicle, in a fine mill, about as in paint grinding. Varnish, however, is such an important and useful material and its nature and properties often so little understood that it will be worth while to review briefly the main points in its manufacture. The accomplishment of the desired result in the use of these materials is simply a matter of handling and applying them in the proper way.

The manufacture of ordinary oil varnish is a highly developed art in its finer details, but the broad principles are simple enough. The resins used in varnish making—kauri, copal, manila, pontianac, etc.—some of which were mentioned in the previous article, dealing with the manufacture of lacquers, are not soluble in linseed oil, but must be melted and heated to a high temperature before a satisfactory combination can be made. The process of varnish making, therefore, consists in melting a certain amount of the resins in a large copper kettle mounted on small wheels. This is placed over a coke fire, under a broad stack, and heated until the resins have melted and reached the proper degree of fluidity. During this heating various oils and volatile compounds are driven off so the gums will shrink from 10 to 25 per cent by weight.

Refined linseed oil, which has generally been heated or otherwise treated previously, is slowly added to the melted mass and thoroughly stirred; the cooking is then continued until the solution and combination of the materials is complete, a process which calls for much experience and skill. After being allowed to cool for a time, the mixture is thinned to the proper body with turpentine or light mineral oils and the varnish is then drawn off into large tanks and allowed to stand for months or even years, in order to settle and age.

A large variety of varnishes can be made, since any one of several gums or combinations of these may be used and the amount of oil added may vary widely. A given varnish may be entirely satisfactory for one purpose and practically useless for another; therefore, varnishes are, or should be, made up with due consideration of the purposes for which they are intended.

When different pigments are ground in a varnish a rather thick liquid is obtained, which gives a more or less glossy finish of any desired color. These varnish-enamels are practically air-drying if given enough time, but are almost always dried or baked at a gentle heat, generally not above 180 degrees Fahr. at the most, for a period varying from one to three or four hours. The degree of heat, and to some extent the length of time, depend on the color of the enamel and on the varnish base. The light and delicate colors usually darken for one reason or another very readily under the influence of heat so great care must be taken to keep all conditions well within the danger line or spoiled work will be the result. Of course, darkening is usually not so objectionable with the darker colors and it is often possible to use a higher temperature with these.

It can be noted that the maintenance of a steady, uniform temperature in all parts of the oven, with sufficient ventilation to remove quickly all products of evaporation or combustion and supply fresh air is of much more importance in the case of these enamels than with the black japans. It requires so little to disfigure or spoil work of this nature it is usually necessary to exercise every precaution if high grade work is to be produced, and this applies not only to the baking, but to the application as well. Thus, the parts must be entirely free from grease or dust and dirt; in the latter case streaks or a muddy effect will be produced, especially if the material is applied with a brush. Brushes and spraying machines must be thoroughly cleaned before using and, as in the case of lacquers, varnishes or any high grade finishes, the air of the finishing room must be kept as free from dust as possible and the parts should be allowed to dry only on a covered truck.

Consideration of True Enamels

Color work of this sort generally receives more than one coat, so each is lightly sanded and smoothed down to remove all rough spots and provide a surface to which the next one can adhere, before the latter is applied.

Sometimes a final coat of clear varnish is given to protect a color coat or bring up the gloss, but the application and baking of this is about the same as given for the preceding coats.

The true enamels, which were mentioned briefly, are an entirely different class of materials from those which have been considered so far, being, in effect, glasses. The ordinary metal finisher is not called on, as a general thing, to produce this kind of work, but those engaged in the finishing of jewelry and art goods usually have more or less of it to do and, further, since the enameled ware industry is a big one and is still growing, it is worth while to briefly discuss the process.

While the enamels are essentially glasses they are of somewhat different composition and properties than the ordinary material with which we are acquainted and may broadly be considered to be compounds of calcium, aluminum, potassium and sodium with silicon and boron. These elements may be derived from a mixture of calcite or fluorspar, sand or ground quartz, feldspar and clay, soda ash and borax. Naturally, enamels for different purposes have different compositions and various substances other than those given may be added; thus, manganese dioxide is employed in dark colored enamels, as an oxidizing agent, while cobalt oxide and other oxides and compounds find a wide use. Certain metals are introduced for the purpose of giving a desired color as, copper or chromium for green, uranium or titanium for yellow, manganese for violet or brown, cobalt for blue, tin oxide for white, etc.

There is almost an endless number of formulas for enamels and a good deal of secrecy is observed by the manufacturers regarding the materials and proportions of each used, although the general process of manufacture is the same, substantially, for most of these. After the materials are weighed they are well mixed and charged into a reverberatory furnace heated by gas or oil and melted down to a clear glass. When this is accomplished the molten mixture is run into water and thereby broken up into fine particles which are then ground in a mill to a powder which is usually suspended in water.

In applying the finish the thoroughly cleaned parts are dipped into this suspension or the finish is brushed or sprayed on and allowed to dry; then the parts are placed in a muffle or suitable furnace and heated to a temperature of 1,000 degrees Cent. or more. This intense heat fuses the particles of enamel into a hard, strong coating of glass. One or two additional coats, depending on the nature of the work, may then be given, each applied and burned as before.

The final result is a hard, glassy surface which is capable of withstanding severe wear and tear, is not easily affected by acids or alkalis and possesses considerable decorative merit.

Melting Malleable Iron in Electric Furnace

AN EXCEEDINGLY interesting method of melting and refining malleable iron for castings has been developed by W. G. Kranz, vice president, The National Malleable Castings Co., Cleveland, involving the use of a primary melting furnace, such as a cupola or air furnace, together with a bessemer converter and an electric furnace. The details of the process are described in a patent issue to Mr. Kranz on Dec. 5, 1916, and assigned by him to The National Malleable Castings Co. This patent, No. 1,206,861, reads as follows:

"My invention relates to the treatment of iron intended to be made into castings; and is designed to overcome the difficulties resulting from the presence of relatively high carbon and also in some cases of relatively high manganese and silicon, but particularly of carbon, in the iron.

"In carrying out my invention, pig iron or scrap, or both, high in carbon, and which may contain appreciable percentages of manganese and silicon, are melted in any suitable furnace, such as a cupola, open hearth, or air furnace. A portion of the melted charge depending on the amount of carbon and other impurities to be removed is then tapped out of the furnace and transferred to a bessemer converter, in which the carbon, manganese and silicon are wholly or partially blown out. The treated metal, and the remainder of the charge direct from the furnace, are then poured into a ladle or other container with the result that the percentage of carbon (as well as the percentage of the manganese and silicon) in the complete charge is reduced to within desired limits, and may then be cast. If a further refinement is desired, the charge may be transferred to an electric or other suitable refining furnace, in which the refinement of the metal is completed.

"It may also be desirable to tap the metal in the first instance from a blast furnace, in which event a proper proportion of the metal is first introduced into and treated in a bessemer and the carbon and other substances reduced. The treated metal is then mingled with the remainder of the charge from the blast furnace either to be cast or to be further treated in a refining furnace.

"I have found that with a charge of iron containing 3.25 per cent of carbon very satisfactory results can be obtained by taking one-fifth of the charge, introducing it into a bessemer and reducing the carbon to 0.50 per cent or less by treatment therein, so that when the treated metal is mingled with the remainder of the charge the percentage of carbon in the whole is approximately 2.70 per cent. After further treatment in an electric furnace the metal thus refined is extremely well adapted for malleable castings, and can be produced at a very much lower cost and in much less time than is the case when the reduction of the carbon is effected in either the melting furnace or in the electric furnace. If it is desired to produce gray iron castings, suitable additions such as manganese or silicon may be made in the vessel to which it has been transferred, and the charge may then be cast.

"The advantages of my invention will be apparent to those skilled in the making of iron castings, since the troubles arising from high percentages of carbon and in some instances from high percentages of manganese and silicon, are practically eliminated, and iron containing excesses of such materials is rendered commercially available for malleableizing and other purposes at a low cost and with a considerable saving in the time required for its conversion into castings. By the use of my invention it will be seen that the carbon and other substances may be reduced and equalized in any proportions depending on the character of the iron which it is desired to produce. It is, however, not usually desirable to reduce the carbon below 1.50 per cent; and while for certain purposes the treated metal may contain any per cent below the carbon content of the untreated metal, in most instances it is desirable to reduce the carbon to below 3 per cent.

"The terms and expressions which I have employed are used as terms of description and not of limitations, and I have no intention, in the use of such terms and expressions, of excluding any equivalents of the features shown and described, or portions thereof, but recognize that various modifications in the method as described and in the apparatus as used are possible within the scope of the invention claimed."

The National Malleable Castings Co. is constructing a new plant in Cleveland in which apparatus for making malleable castings substantially according to the foregoing process is being installed. The equipment, it is understood, will include two 12-ton electric furnaces of the heroult arc type, bessemer converters, cupolas, traveling cranes, machine tools, etc. The building, which is irregularly shaped, will be approximately 575 x 725 feet. The plant occupies a site of 32 acres, purchased a few years ago.

The Manufacture of Manganese Steel Castings

A Discussion of the Difficulties Encountered in Making Alloy Castings —The Application of Manganese Steel to Various Kinds of Work

By W S McKee

ALTHOUGH the steel foundry industry has made tremendous strides in the past decade, the difficulties surrounding the manufacture of steel castings are scarcely less embarrassing at present than they were 10 years ago. As fast as the problems standing in the pathway of progress are solved and removed, new perplexities arise owing to the enlargement of the field of operations. The growth of the industry has led to specialization and at present there are several large steel foundries in the United States and abroad that concentrate their efforts on the production of high manganese castings. On account of its peculiar properties including remarkable resistance to abrasive action, manganese steel is used for a great variety of industrial purposes and the shops manufacturing this material in the United States now have a combined capacity of approximately 70,000 tons per year.

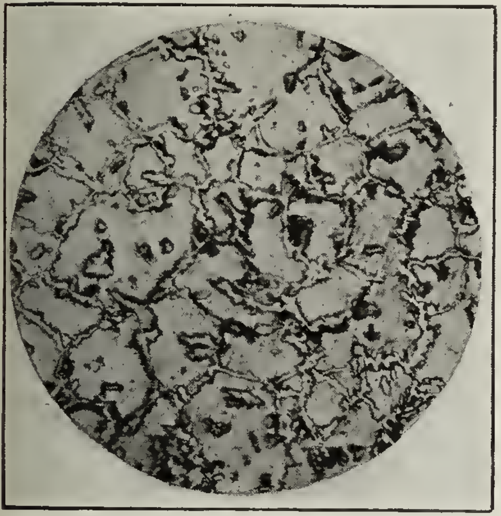

FIG. 1 — MICROSTRUCTURE OF CAST MANGANESE STEEL UNTREATED, MAGNIFIED 100 DIAMETERS

Strange to say, however, the difficulties surrounding the manufacture of manganese steel castings do not seem to be as fully appreciated as those connected with the production of ordinary carbon-steel castings, possibly because they have not been as widely discussed. As a matter of fact, the manganese steel foundryman finds himself confronted with all the problems of the ordinary steel foundryman, plus a host of special complications arising from the peculiar physical and chemical characteristics of the material with which he is working. In order to achieve success it is necessary to have special experience all along the line, particularly with reference to melting and mixing the metals and heat-treating the castings. It is for the purpose of pointing out and discussing some of the peculiar problems of the manganese steel foundrymen that this article has been written.

Manganese steel was developed originally in England, largely through the efforts of Sir Robert Hadfield. It has been manufactured on a commercial basis for nearly 26 years. The first manganese steel castings made in the United States were turned out in 1892. Originally it was considered impossible to make manganese castings successfully weighing over a few hundred pounds, but at the present time large rolling mill pinions, crusher heads and similar castings weighing up to 30,000 pounds each are being produced regularly and it does not appear that the limit of weight has been reached by a considerable margin.

A Great Variety of Uses

Manganese steel castings are used for a great variety of purposes, including parts for asphalt presses, ball mills, brick and tile machinery, cement kilns, Chilean mills, clay mills, coal breaking machinery, coal mining machinery, concrete mixers, copper converters, traveling cranes, crushers, dredges, gears, grab buckets, steam shovels, lifting magnets, rolling mill machinery, stamp mills, etc. Manganese steel also is employed for the manufacture of safes, railway frogs and crossings, foundry tumbling barrels, etc.

As manufactured at present, manganese steel is similar in analysis to ordinary converter metal except that it is high in carbon and unusually high in manganese. In ordinary commercial castings the proportions of the latter metal range from 11 to 13½ per cent. This combination of elements gives the finished castings certain distinctive metallographic and physical qualities, which wll be detailed later in this article. From one standpoint, manganese steel is similar to malleable iron in that the casting as it comes from the sand is almost glass hard and very brittle. It must be made ductile by an annealing or heat-treating process. The heat treatment is a very essential part of the process, and must be properly manipulated to insure satisfactory results.

The necessity for heat treatment limits the thickness of section which it is possible to cast successfully with manganese steel. Originally the castings were made with comparatively thin sections, but researches carried on during the past few years by prominent manufacturers have resulted in a gradual increase in the thickness of section that it is possible to treat successfully, until at present castings with walls up to 5½ inches in thickness are handled satisfactorily. Heavy castings are cored out to a minimum thickness of 5½ inches. This not only serves to eliminate the internal stresses which invariably are set up in a very thick casting, but also reduces the weight and inertia of the piece, an important consideration if the casting is a moving part in a machine. At the same time, the maximum annealing thickness of 5½ inches is sufficient to permit the use of manganese steel for the heaviest classes of machinery. It is evident from the foregoing, that although manganese steel is made in a converter and cast in sand molds, the process is by no means a simple one. Unusual experience and ability are required if successful results are to be obtained.

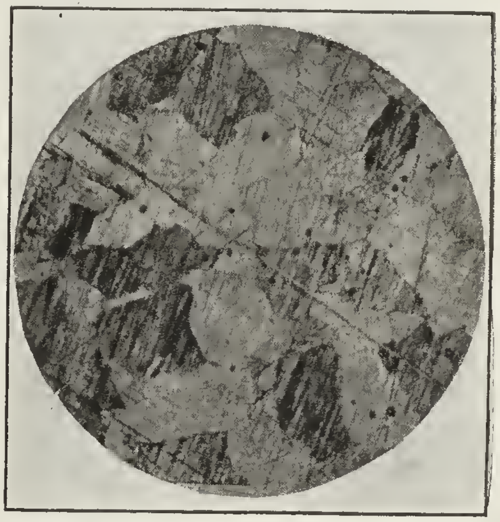

FIG. 2 — MICROSTRUCTURE OF CAST MANGANESE STEEL PROPERLY HEATED, MAGNIFIED 100 DIAMETERS

The early papers of Sir Robert Hadfield mentioned tensile tests of specimens of manganese steel showing an

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A paper presented at the September, 1916, meeting of the American Foundrymen's Association, Cleveland. The author of this paper, is vice president of the American Manganese Steel Co., Chicago.

ultimate strength of approximately 100,000 pounds per square inch with elongations as high as 40 per cent. In some few instances an ultimate strength of 150,000 pounds per square inch is mentioned by Mr. Hadfield. That the physical characteristics of manganese steel are superior to many high grade steels is indicated by the following figures averaged from a series of 19 tests of manganese steel made by Robert W. Hunt & Co., Chicago. The figures are as follows: Elastic limit, 53,396 pounds per square inch; tensile strength, 108,460 pounds per square inch; elongation in 2 inches, 33.71 per cent; reduction of area, 38.56 per cent.

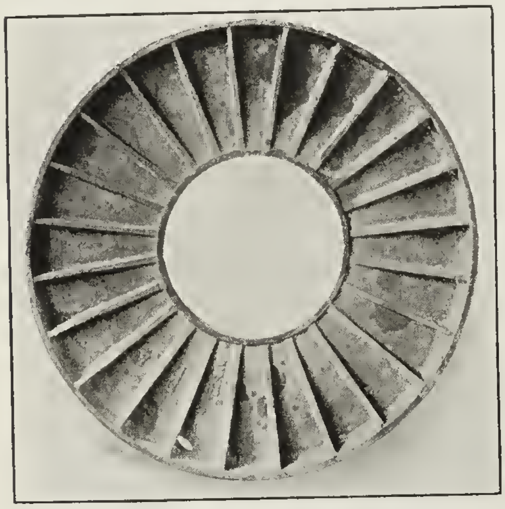


FIG. 3—COIL SHIELD FOR LIFTING MAGNET

Manganese steel does not owe its wear resisting qualities to its hardness. When subjected to the Brinell test, it shows an average hardness number of about 200. The extreme outer fibre of the treated steel shows a slightly lower hardness number than at a depth of about ⅛-inch. From the latter point the hardness remains constant to the core of the casting. The lowering of the hardness at the surface is due to the oxidation of the carbon which forms on the surface during the heat treatment. The toughness of the material is due to its great molecular cohesion which causes the particles to flow rather than to tear off. When tested with a scleroscope, manganese steel shows a hardness of from 40 to 50. The specific heat ranges from 0.145 at ordinary temperature to about 0.20 at 1,200 degrees Cent. Between ordinary atmospheric temperatures and 600 degrees Cent., the heat conductivity appears to be about one-third that of low carbon steel. The specific gravity of manganese steel ingots is nearly the same as the result obtained by the usual method of determining specific gravity with a chemical balance, using a small specimen of cast steel. The rolled steel is slightly heavier than the cast material.

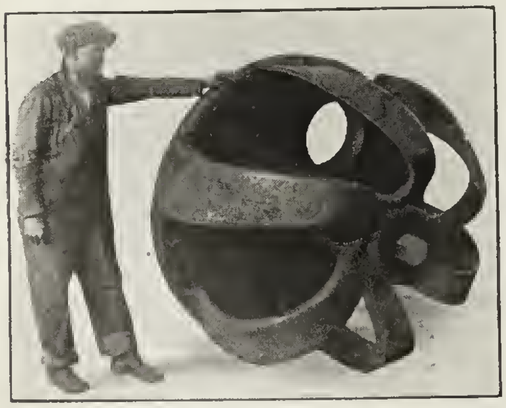


FIG. 4—LARGE MANGANESE STEEL CUTTER HEAD

Peculiar Electrical Properties

The electrical resistance of manganese steel is approximately 3.4 times the resistance of ordinary bessemer steel. At temperatures between 100 and 600 degrees Cent. the electrical resistance is said to remain practically constant. Manganese steel is non-magnetic and advantage is taken of this property in the use of this material for shields or bottom plates for lifting magnets, such as are extensively employed in foundries. The shrinkage of manganese steel is excessive, amounting to 5/16-inch per foot as against 3/16-inch to ¼-inch in ordinary steel foundry practice. The high shrinkage creates a number of foundry problems which will be discussed in some detail later. Cast manganese steel has a chemical composition as shown in the following table:

CHEMICAL ANALYSIS OF MANGANESE STEEL.

	Per cent
Carbon	1.25
Silicon	0.30
Manganese	12.50
Sulphur, less than	0.02
Phosphorus, about	0.08

The distinctive characteristics of manganese steel are clearly delineated by the microscope. It is well known that manganese is present in all ordinary steel, but the metal does not become austenitic until about 6 per cent manganese and 0.80 per cent carbon are introduced. Commercial manganese steel generally contains from 11 to 13½ per cent manganese and from 1.00 to 1.30 per cent carbon.

Metallographic Explanation of Characteristics

In the cast state the metal is composed principally of austenite and free cementite, austenite being a solution of iron, manganese and carbide of iron and mangenese, while free cementite is composed of the carbide of iron and manganese which remain undissolved. Free cementite is very hard and brittle and therefore manganese steel is also very brittle in the cast condition. However, upon receiving a proper heat treatment all of the free cementite is dissolved forming austenite which is known to be very ductile and to present a high resistance to wear. We thus have a metallographic explanation of the chief characteristics of manganese steel. In order to obtain the austenitic structure it is necessary that the steel be given a correct treatment. Microscopic examination reveals the fact that if the steel is heated to a proper temperature and quenched in water, it is composed entirely of austenite. By the aid of the microscope, therefore, the proper structure can be determined and together with physical tests and chemical analysis most excellent results are obtained.

The accompanying microphotographs, Fig. 1 and Fig. 2, show the structures of manganese steel as cast and after treatment, magnified 100 diameters. Fig. 1 shows the structure of manganese steel in the cast condition. Fig. 2 shows the same steel heated to a temperature of 1,800 degrees Fahr. and quenched in water. It will be noted that since the heat treatment all of the free cementite has disappeared leaving a purely austenitic structure. If the steel is again heated to over 700 degrees Fahr. the pure austenitic structure is destroyed, seriously injuring the quality of the metal. It, therefore, is imperative that manganese steel should not be heated to a temperature exceeding 700 degrees Fahr. after leaving the foundry where it was manufactured.

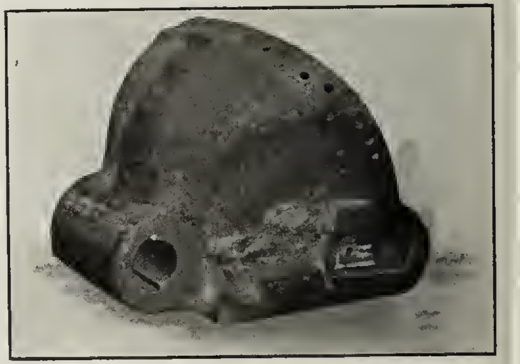


FIG. 5—EARLY DESIGN OF DREDGE BUCKET SHOWING SHARP CORNERS IN BACK EYE

Owing to shrinkage difficulties and to the problems connected with annealing, it is necessary, in order to achieve success in the manufacture of manganese steel castings, to start with the design of the parts. A few simple changes in design may spell the difference between success and failure in the foundry. It is necessary for the designer, however, to have a thorough knowledge of the peculiarities of the metal. The importance of correct design is very clearly indicated by the dredge buckets shown in Figs. 5 and 6. The original type of bucket is shown in Fig. 5 and the improved design in Fig. 6. In Fig. 5 it will be noted that there are two square corners in the back eye. In this design the bushing, with which the eye is fitted, bears on the shoulders created by the two sharp corners previously mentioned. Although these corners were provided with a small fillet it was found extremely difficult to insure perfectly sound metal at this point. As a result, the bucket was apt to fail at one of the points of greatest stress. In the improved design shown in Fig. 6 it will be noted that the two square corners have been entirely eliminated resulting in a much more satisfactory job from a foundryman's standpoint. Fig. 6 not only shows the new form of the back eye but also illustrates the bushing with which the eye is fitted. Generally speaking it is more necessary to avoid an abrupt change in section and sharp corners when making manganese steel than when turning out ordinary low carbon steel castings.

It is necessary that the pattern be provided with the proper shrinkage allowances and for this reason many manganese steel foundrymen prefer to make their own patterns from original drawings supplied by their customers. When patterns are furnished they frequently have to be rebuilt in order to obtain satisfactory results. The allowances for shrinkage are not confined simply to the dimensions of the pattern, but also include the distribution of the metal in the casting. At times it is necessary to add metal to a casting temporarily to withstand shrinkage strains; such additions of metal are removed in the machine shop by grinding before the casting is shipped. In handling work of this character, unusual skill is necessary in order to properly allow for shrinkage stresses. While a majority of the patterns used in manganese steel foundries are made of wood, it has been found advantageous to use metal where great durability is required, as in ordinary practice. A complete manganese steel casting plant, therefore, should include a properly equipped pattern shop provided with band saws, circular saws, woodworking lathes, and boring and mortising machines, together with other equipment for the rapid and economical production of the various kinds of patterns.

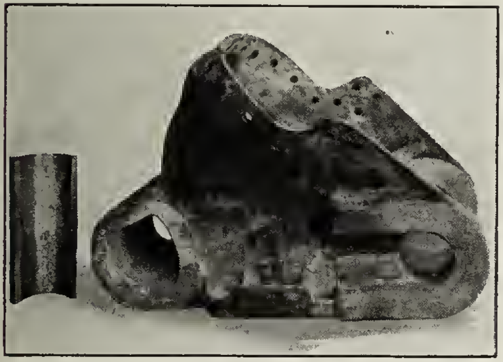


FIG. 6—PRESENT DESIGN OF DREDGE BUCKET WITH CORNERS IN BACK EYE ELIMINATED

The molding floor of a typical large manganese steel foundry is shown in Fig. 9. It will be observed that the crane equipment is extensive including heavy electric traveling cranes which span the entire floor, supplemented by wall cranes. In making molds it has been found that ordinary molding sand and clay binders are unsatisfactory on account of the cutting action of the molten metal. Sands with a high percentage of silica are used and most of the molds are oven dried. Special facing mixtures are required owing to the crushing effect of the shrinking manganese steel. An open facing which will yield readily is necessary, but at the same time sufficient skin hardness to prevent the mold from being washed away is required. Similar difficulties are encountered in providing proper core sand mixtures. These mixtures must be free venting; they must have sufficient strength to stand up properly under the destructive action of the molten metal and at the same time the core must yield readily when the casting commences to shrink. The larger manufacturers of manganese steel have conducted extensive experiments which have enabled them to determine the proper mixtures for facings and core sand and to develop standard formulas.

How the Metal is Melted

For melting the metal standard side blow converters have been found satisfatcory. At the Chicago Heights plant of the American Manganese Steel Co. two cupolas are provided for the primary melting of the metal and four 3-ton converters are installed. The cupolas are situated in a mezzanine floor behind the converters and are so arranged that the metal may be drained directly from the cupola spouts into the converters. The ladle and crane equipment is similar to that found in the average steel foundry handling heavy work.

Manganese steel is a special converter metal to which a quantity of ferro-manganese is added in the ladle. Standard 80 per cent ferro-manganese is employed and it is necessary to provide suitable facilities for melting this material. For this purpose either crucibles or specially designed reverberatory furnaces may be employed. If the latter method is used, considerable experience is required to design the furnace properly and to operate it successfully. The reverberatory furnace, however, has certain advantages over the crucible method, inasmuch as under proper conditions the labor cost is much less. The working conditions in the furnace room also are less severe and the cost of crucibles, no small item at the present time, is eliminated.

The melted alloy is placed in the bottom of the ladle and the steel from the converter is poured in on top, enough ferro-manganese being used so that the castings will show about 12½ per cent manganese when analyzed. This is an average figure; the exact quantity of manganese varies somewhat with the nature of the work. The manganese acts as a strong scavenger, removing the gases and impurities from the metal, leaving it condensed and homogeneous. The production of slag is excessive and before the molds are poured the ladles are allowed to stand for a time in order to permit the alloy to perform its function and also to skim off the slag. The raw materials used in the production of the converter metal include low-phosphorus pig iron and selected steel scrap, similar to those used in the ordinary bessemer steel foundry. The same careful selection is necessary to insure uniformity in the finished product. The metal is handled and poured while very hot.

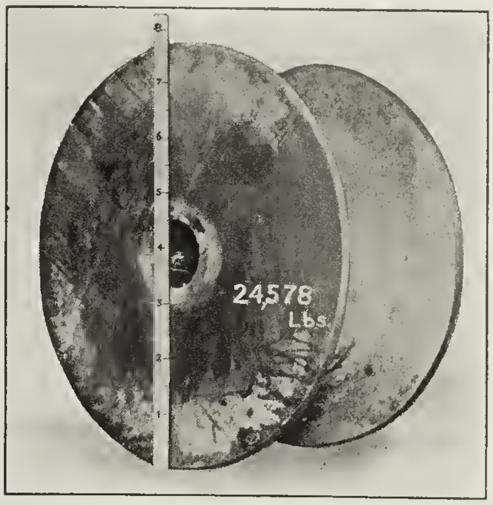


FIG. 7—MANGANESE STEEL DREDGE TUMBLER WEIGHING 24,578 POUNDS

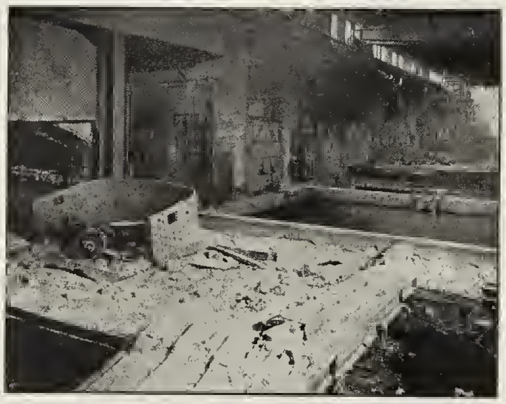


FIG. 8 — HEAT TREATING FURNACES WITH TANKS FOR QUENCHING CASTINGS

As previously mentioned, when the castings come from the sand they are glass hard and before they are suitable for use they must be annealed. For this purpose furnaces of the proper size in which the temperature may be readily controled are necessary, together with quenching tanks and suitable crane equipment for handling the hot castings. The annealing furnaces are of the ordinary open-flue type. Usually they are provided with cars on which the castings are placed for the heat-treating process. It is essential that as little time as possible elapse between the moment when the furnace door is opened and that when the casting is immersed in the quenching tank. It is, therefore, desirable to locate the tanks directly in front of the annealing furnaces as shown in Fig. 8.

In discussing the heat treatment of manganese steel, W. S. Potter in a paper presented before the Western Society of Engineers, at Chicago, Feb. 17, 1909, makes the following interesting statements:

"Upward of 75 years ago men in Sheffield, Eng., understood that steel containing moderate additions of manganese had certain properties which could be described as those of carbon steel, and that steels containing a higher percentage than 5 per cent or 5½ per cent were very weak and brittle.

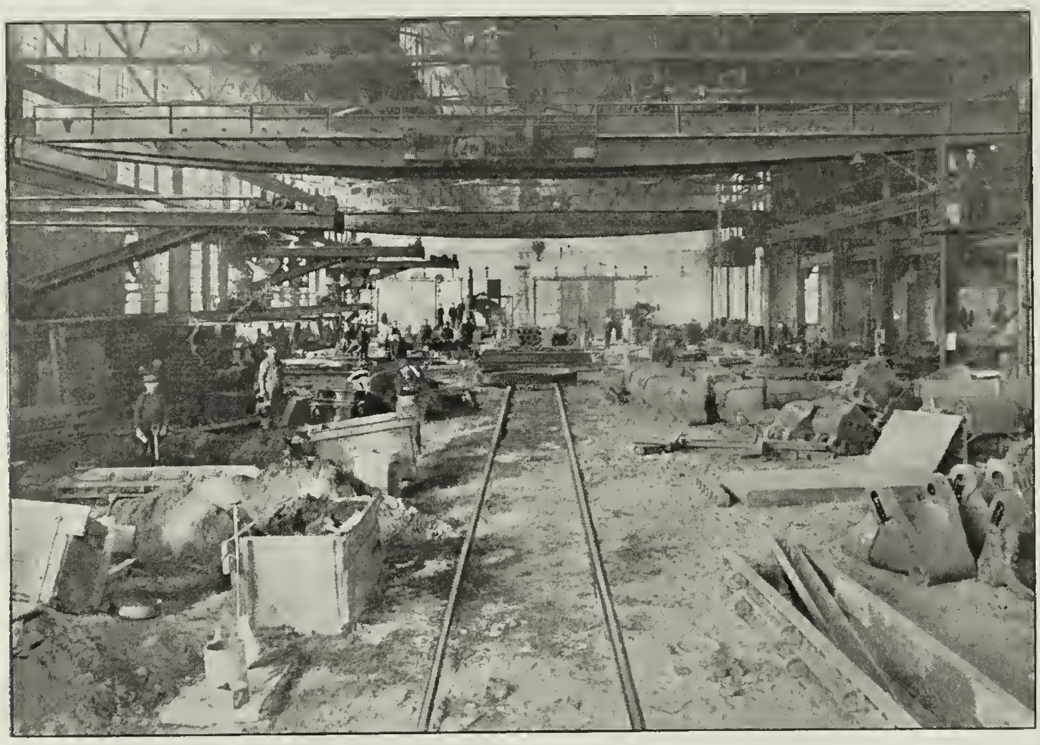


FIG. 9—GENERAL VIEW OF MOLDING FLOOR OF TYPICAL MANGANESE STEEL FOUNDRY—NOTE EXTENSIVE CRANE EQUIPMENT

"Some 30 years ago the Hadfields, father and son, or their associates, found, and the son advertised, the fact that castings and forgings containing the higher percentage of manganese, after heating to a high temperature and quenching with water, were very strong and tough and that the treated steel had remarkable resistance to abrasive wear. The proportion of manganese mentioned as suitable for track-work castings, in Hadfield's early patents is 11 per cent. No heat treatment was mentioned in the early papers, but later a treatment was announced and consisted in heating the castings at first slowly and then rapidly to 800 degrees, 900 degrees, or 1,000 degrees Cent., and immediately quenching in water. No theory covering the necessity of this reheating and quenching was given.

"Manganese steel of ordinary composition poured in a layer about ¼-inch to ½-inch thick in a chill mold will, when cold, bend double, and has all the usual toughness of reheated and quenched manganese steel. Castings from the same ladle of steel poured in sand molds have a toughness approximating the toughness of the reheated and quenched metal in inverse proportion to the thickness of the sand cast section. For example, a sand-cast section ½-inch thick will usually bend from 45 degrees to 90 degrees before it breaks by cold bending. A section 2 inches thick usually breaks in cold bending before it is deflected as much as 20 degrees. The thinner section is whiter and has smaller crystals than the heavy sand-cast section, and the chill-cast section is still whiter and has still smaller crystals than the thin sand-cast section. If the three specimens are heated to 1,000 degrees Cent. and quenched in water they will exhibit in each case a very remarkable and practically equal degree of toughness. In all these cases the steel has practically the same hardness. The chill-cast specimen, before reheating, is the hardest; the sand-cast specimens are the softest. If the specimens are now heated to 700 degrees Cent., or even a little lower temperature, held for, say one-half hour at this temperature, and cooled slowly to ordinary temperature and broken, they are surprisingly weak, and as a rule, bend but slightly before breaking. The crystals are very large and it is obvious that no strong cementing materials are present to bond the crystals. A section 3 inches thick cooled slowly from the heat of casting, and put under a drop weight will break about as readily as an equal thickness of a fair quality of gray iron and will frequently show crystals with a mirror surface as large as 1¼ x 1 inch. For the most part such a section so treated and broken will show crystals about ¼-inch to ⅜-inch on a side. A specimen heated to above 700 degrees Cent. and cooled slowly to below 600 degrees Cent., is very weak. If this specimen is reheated to 700 degrees Cent., and quenched in water only, a slight increase in toughness is noted. The crystals are still apparently as large as ever. The bond between the crystals is almost as weak as before, and yet from the other tests it is clear that the steel crystalizes or re-crystalizes considerably below 700 degrees Cent.

Analysis by Color Tests

"Comparing this steel with a carbon steel it is obvious that the cementing materials are not taken into solution at as low a heat in the manganese steel as in the carbon steel. In the carbon steel, the size of crystals, strength, toughness, etc., may be redetermined any number of times by reheating to 700 degrees Cent. and cooling, and as is well known, the physical properties are governed by the rate of cooling. The manganese steel after being put in a weak condition due to slow cooling from 700 degrees or above is only put in a condition of maximum toughness by reheating to a much higher temperature and then cooling rapidly enough to prevent either mechanical or chemical separation. A comparison of color carbon tests with determinations of total carbon by combustion, shows that the slow-cooled steel has a much smaller amount of carbon in the condition which permits of the determination of carbon by color than the manganese steel which has been rapidly cooled. The highest color result is obtained from the thin chill-cast section, the next highest from a specimen heated for a short time only and quenched in water. The lowest carbon result, by color test, is found in the specimen which has been heated to a high temperature, maintained at this temperature for some time and cooled very slowly. The chill-cast specimen showing by total carbon determination 110 points carbon, by color test may show 105 to 108 points. The specimen annealed at a high heat will give color results ranging from 0.60 to 0.95 per cent, depending upon the time to which the specimen was exposed to the highest temperature, the rate of cooling, and the percentages of manganese and silicon that are present in the metal.

"As might be anticipated from the general knowledge pertaining to the art of 'black heart' malleable iron manufacture, the percentage of silicon plays a very important part in the decomposition of carbides of iron and manganese in manganese steel. Manganese steel is readily burned when heated, and this burning is more difficult to avoid as the temperature increases. For this reason it is usual to heat for quenching only to a point sufficiently high to give the characteristic toughness in the quenched metal. If castings or other finished shapes are reheated for toughening to a high temperature they are apt to be very generally affected with deep cracks. To avoid burning and cracking the reheating is generally stopped at about 1,000 degrees Cent."

In operating the annealing ovens or furnaces it is necessary to heat the castings up slowly so as not to create expansion strains which will cause cracks. If the castings are heated rapidly the outside, of course, heats faster than the core, resulting in internal stresses of a serious nature. After the proper annealing temperature is reached, from 1,600 to 2,200 degrees Fahr., the castings must be given a soaking heat for several hours in order to bring the molecules into a state of equilibrium. The time required for this operation varies from 4 to 24 hours depending on the size and character of the casting. As previously stated, the thickness of the metal which can be successfully annealed has gradually been increased until now castings with walls 5½ inches thick are handled without any great difficulty. It is advisable to have the water in the quenching tanks as cold as possible in order to cool the castings quickly, before there is any time for internal structural changes. The men drawing the castings from the annealing furnaces must be protected from the heat with special clothing and helmets. Respirators also are desirable owing to the noxious gases emitted from the furnace when the door is opened.

Castings Not Easily Cleaned

The proper cleaning of manganese steel castings presents many problems in itself. Very little sand adheres after the casting comes from the quenching bath. The metal is so tough, however, that practically all of the trimming operations must be conducted by grinding. Extensive portable, electrically-driven grinding equipment is necessary for this purpose. A general view of a modern manganese steel foundry grinding and cleaning room is shown in Fig. 10. It will be noticed that a heavy investment is required in order to properly equip this portion of the plant.

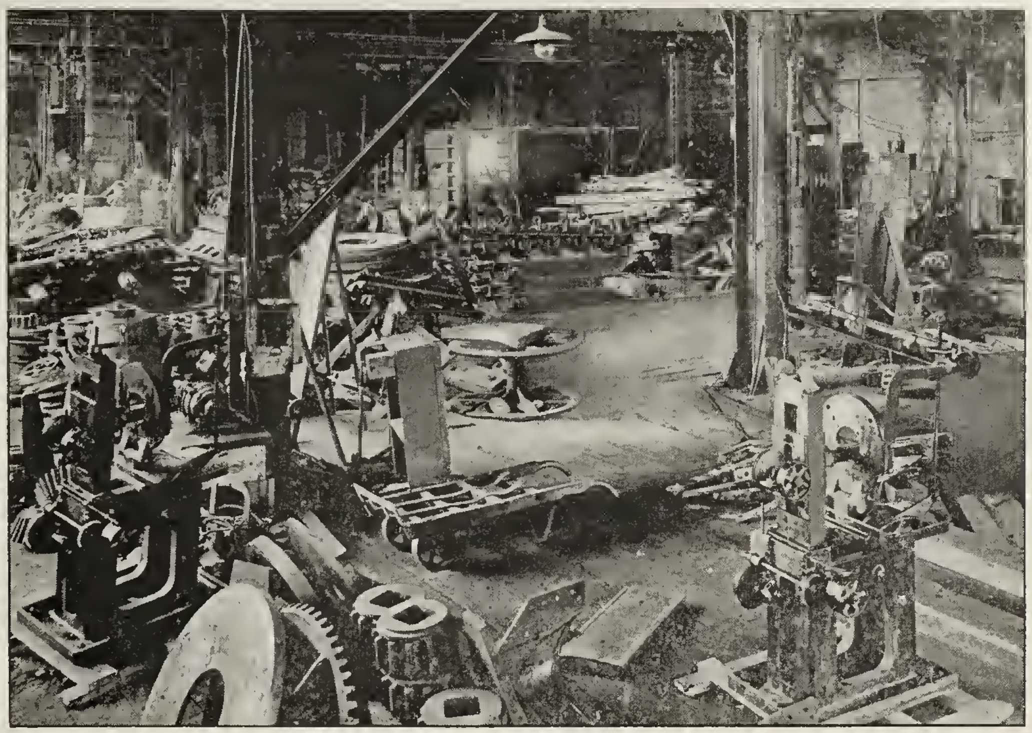


FIG. 10—GRINDING ROOM IN A LARGE MANGANESE STEEL FOUNDRY

Most manufacturers of manganese steel castings have found it advisable to establish extensive machine shops in connection with their plants. If the castings are to be finished in any way, special equipment is necessary. Ordinary machining methods are unsuccessful and grinding must be resorted to. Holes, more than ¼-inch in diameter, are cored out of the castings and ground to size with special wheels. When it is necessary to drill smaller holes or to cut threads soft steel or wrought iron inserts are set in the molds at the desired points like chaplets and the metal is cast around them. Incidentally this adds to the difficulties of the foundryman. Sometimes bushings are set in the hubs of gear wheels when it is desired to machine them by ordinary methods. Liberal allowances of metal are made for grinding in order to minimize the danger of spoiling the work in the machine shop.

It is necessary for the machine shop foreman to exercise his judgment continually; coarse wheels and heavy cuts are used so that the metal is removed rapidly, although by no means as easily as would be the case were it possible to employ ordinary cutting tools.

Some mention already has been

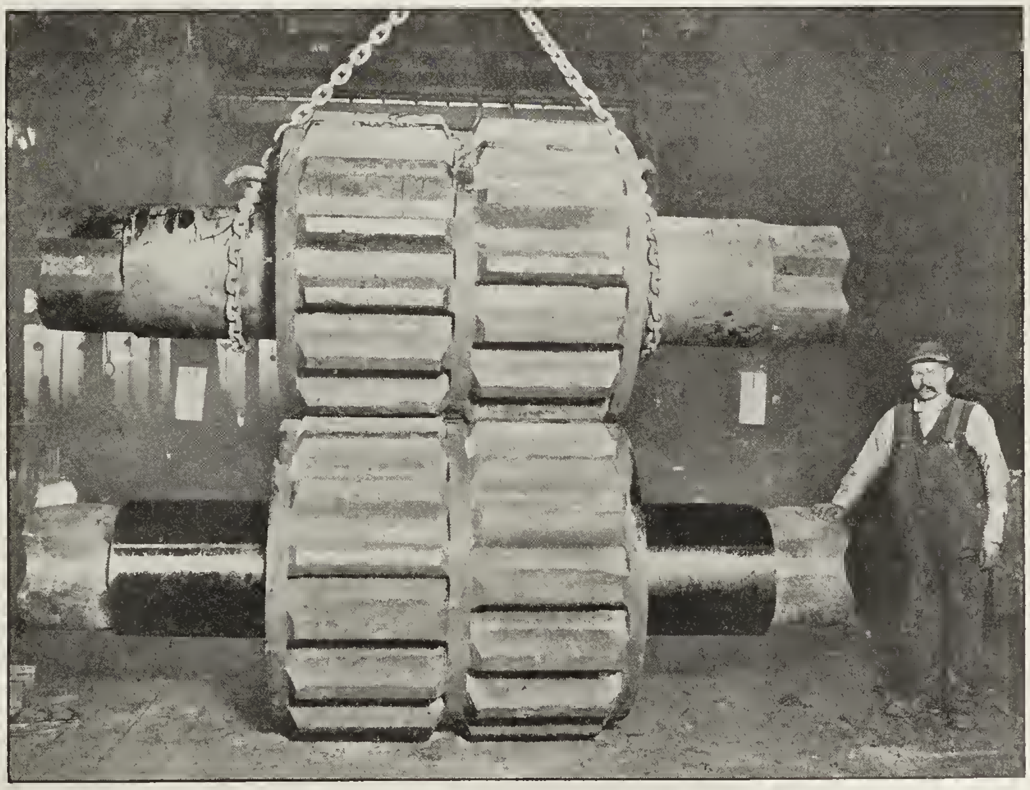


FIG. 11—HEAVY 52-INCH MANGANESE STEEL ROLLING MILL PINIONS

made of the purposes for which manganese steel is used. In the foundry, manganese steel is used for the linings for tumbling mills as well as for gears, crane wheels, elevator buckets, grab buckets, lifting magnet shields, etc. This material is particularly desirable for lining tumbling mills owing to its extreme resistance to abrasion. Where loads are heavy, manganese steel is extensively employed for gears and for the past three or four years it has been possible to produce manganese steel spur gears with the teeth ground theoretically correct. Ground gears now can be provided up to 44 inches pitch diameter with a 10-inch width of face. Many ordinary steel gears are cut with a range cutter which does not leave the rolling contact theoretically correct, whereas in grinding manganese steel gears a trimming arrangement is placed on the grinder for the purpose of dressing the emery wheel to the proper contour of the tooth face, so that when the mating gears are meshed each tooth is provided with a perfect contour on which to roll. After two years continuous service, the wear on a set of heavy high-speed manganese nest gears recently was measured. These gears had a 10-inch face and when new, the tooth measurement at the pitch line was 0.684-inch. At the conclusion of the two years' service, the tooth measured 0.601-inch. These gears are still in service after having more than earned their original cost and barring accidents they should be good for many years to come. The total wear was less than 0.1-inch.

Manganese steel has advantages for crane wheels where uniform diameters must be maintained on the drives to insure straight alignment in travel. A microscopic examination of a manganese steel wheel under load will show a flat spot instead of a line contact as in the case of hard metal wheels. Manganese steel under these conditions is springy and recoils as the load is released. About 30,000 pounds always has been considered a safe working load on chilled iron wheels for this purpose. Manganese steel crane wheels, however, are in successful use with rolling loads of 90,000 pounds per wheel.

Manganese steel also is extensively employed in the manufacture of rolling mill machinery. It has been found particularly suitable for the pinions on heavy roughing and blooming mills. A set of typical rolling mill pinions made of cast manganese steel are shown in Fig. 11. These pinions are cored out to a maximum thickness of 5½ inches, which decreases their inertia. Many other machine parts around steel mills are now being made of manganese steel including pipe drawing balls, chafing plates, sprockets, cams, draw chains, unloader chains, conveyor chains and buckets, screens, crusher castings, etc. It may be easily appreciated that the successful production of manganese steel castings involves a wide experience.

A Quick Method of Making a Gear Cover Casting

By E. W. Wallbank

A short time ago the writer was given a sketch for a gear cover with instructions to secure a casting as quickly and cheaply as possible. As will be seen in Fig. 1, the cover was 38¾ inches in diameter with the pinion cover cast onto it. First a piece was made exactly the shape and size of the pinion cover, with a location strip screwed on it temporarily. A ¾-inch hole was bored through this strip 21 inches from the center of the hole in the pinion cover, as shown in Fig. 5.

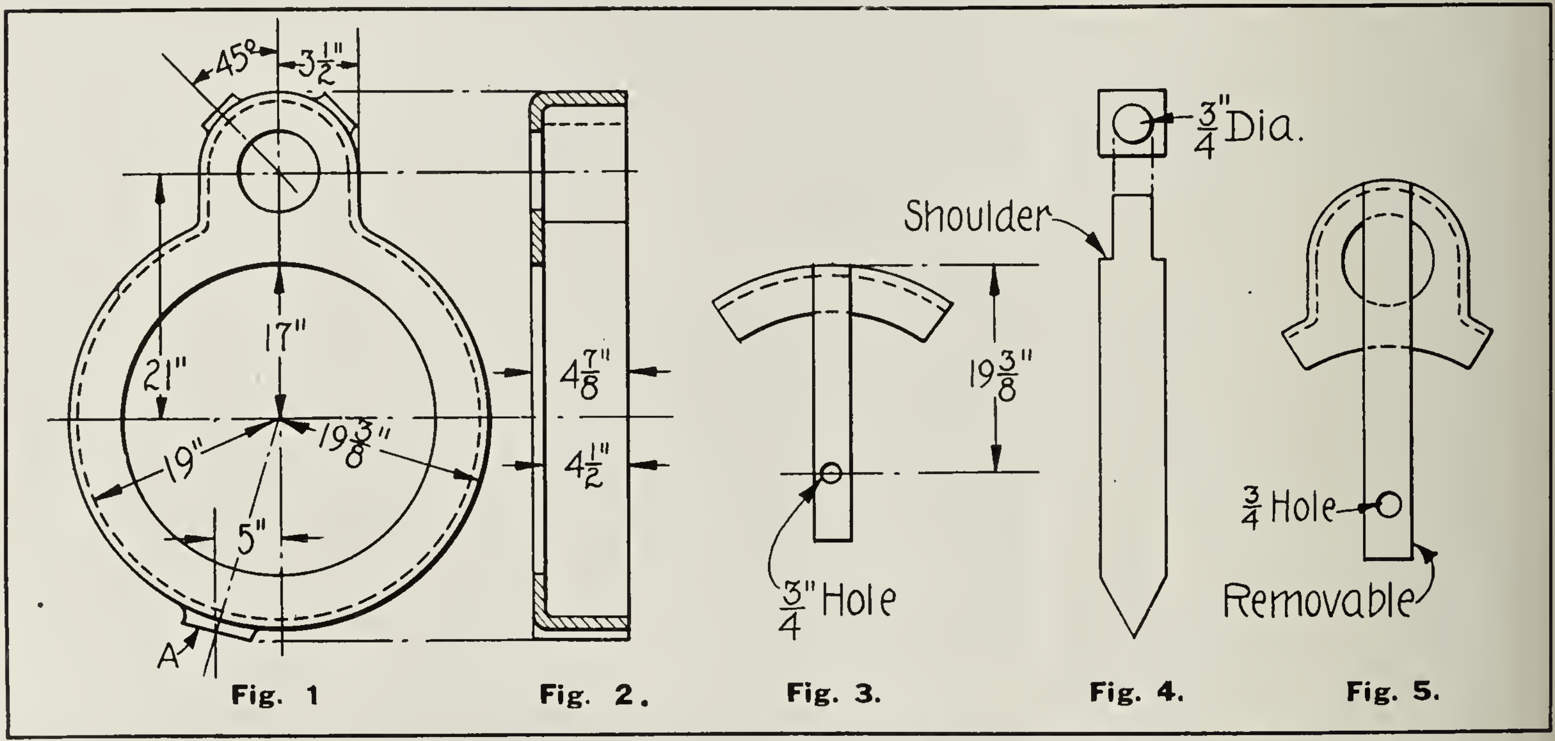


Fig. 1 **Fig. 2.** **Fig. 3.** **Fig. 4.** **Fig. 5.**

PLAN OF GEAR COVER CASTING AND DETAILS OF SWEEP FOR MAKING THE MOLD

A piece was next made as shown in Fig. 3, with a location strip screwed permanently onto it. A ¾-inch hole was bored through this strip 19⅜ inches from the outer periphery. Next a center post, Fig. 4, was planed, and turned to ¾-inch in diameter for about 1 inch from the end. This allowed the ¾-inch holes bored in the location strips to fit snugly over it.

A bed was swept up in the foundry floor and the center post, Fig. 4, was driven down until the shoulder was 4⅞ inches from the bottom of the bed. The piece shown in Fig. 5 was located level and rammed up, after which the location strip was removed and the sweep shown in Fig. 3 placed in position and rammed up in sections until a complete circle was made. A center line was drawn through the mold with the aid of a center on the pinion cover pattern and the lathe center of the center post. The loose piece A was then bedded in at the proper place.

These sweeps were completed in less than 3½ hours and the lumber required was taken from the scrap box. The casting was poured the next day and was perfect in every respect.

The Damascus Bronze Co., Pittsburgh, has purchased additional property, 75 x 100 feet, adjoining the site of its plant.

The Fundamental Principles of Plate Mounting

Methods of Determining the Position of Patterns in Various Kinds of Work—Use of Metal Patterns and Plates for Permanent Mounting

By R R Clarke

AT THE outset we will state that we advance no claims whatever of offering something entirely new in principle or altogether original in conception. Time is comparatively recent when the idea and possibilities of mounting patterns from a mold was new to us, though we have since learned of some few foundries in which the basic principles were recognized before. At present it is doubtless new to others, for we know of foundries where its advantage is not yet in evidence. The object of our article must, therefore, become a desire to afford the idea a wider range of publicity and yield its advantage a large field of usefulness. To accord the plan and execution of a simple method of plate mounting an intelligent discussion and point out its advantages is an end as fair as we can hope to attain, nor do we aspire to any other.

A brief explanation of a few terms necessary to the discussion may be of value and we herewith submit it.

Points are determining factors of position and strictly speaking, have position only.

Mechanical points are those located and indicated by actual measurement. They have more or less of dimension and vary in correctness of relative position with the exactness of the measurement and the efficiency of the instrument.

Geometric points are those located through abstract calculation. They have strictly position only, are infinitely small and absolutely correct in relative position.

The older method of plate depends in every detail on measurement while in the method under discussion this is true in one detail only. In all other instances the coincidence of position falls under the unerring control of mathematical accuracy.

This simple method derives its advantage chiefly from its simplicity of execution. Given the patterns and plates, any molder can mount those of more common type in less than one hour's time, and that with a degree of coinciding exactness which is not always obtained by measurement. In the complex all positions are measured from lines or points having fixed and identical relative position to the pin holes in cope and drag plate. Thus every measurement admits the possibility of a shift.

The simple method depends on two points in the flask plane of the plate to find all lines of coincidence in the pattern field of both cope and drag In the drag plate these points are the centers of the flask pin holes; in the cope plate they are the identical points of coincidence which constitute the centers of the plate pin socket hole. It might be noted here that the centers of these holes approximate the invisible geometric point. Thus the only mechanical precaution in the simple method is that which insures in all plates strict uniformity and exact coincidence of flask pin holes. Any machine shop, at small cost, can rig a jig for this purpose. The skill and equipment essential to results in the complex are sorely missing in many foundries, while the expense of getting it done elsewhere makes first cost a serious consideration. In the simple the cost is little more than that of the plate and the patterns. Using pattern plates drilled and pinned to neatly identical changeable flasks, the location of all coinciding pattern positions in similar plates is governed by the following principle:

Determining the Pattern Position

The pattern position in the plane of the mold will indicate the pattern position in the plane of the plate when the plate is applied in pin-hole position to the mold. This principle is but an illustration of the general truth that two points determine the position of all points in the connected lines of a plane. Evidently the only thing to accomplish in the simple method is to catch the pattern on the plate where it is in the mold when the plate is applied in pin-hole position to the mold, and hold it there.

This catching-the-pattern feature admits a wide range for variation in method and affords excellent opportunity for comparison of ideas. One essential departure from the complex in the simple method is that the flask, pins and pin holes must lie within the bounding lines of the plate and not outside of them on the machine.

Most machines can be made or cut out to accommodate this feature which is really an advantage in that it does away with dowel pins and the possibility of a shift therefrom.

In considering those methods for the efficiency of which the author can testify, their individual features suggest the following order:

1—Patterns of level parting lines without stripping plates.
  A—Mounting the individual pattern.
    a—On the same plate.
      1—Temporarily.
      2—Permanently.
    b—On separate plates.
      1—Temporarily.
      2—Permanently.
  B—Getting the mounted pattern from the sand impression of the individual pattern.
      1—On the same plate.
      2—On separate plates.
2—Mounting patterns of depressed parting lines without stripping plates.
  A—By casting or cutting-out the locality of depression in the plate.
  B—By using a skeleton plate.
3—Mounting patterns with stripping plates.

In mounting the level-parting pattern direct on the same plate temporarily, both the pattern and plate can be made of wood, though in general, wood plates are not to be recommended. At the pin-hole position flanged bushings, neatly fitting the flask pins can be inserted. Both sides of the plates should be planed and sand-papered uniformly smooth and level. Long iron pins turned to neatly fit the flask and slightly full in the center can be inserted in the pin-holes of the plate. With this preparatory equipment observe the following:

Use plate for follow-board with flask in pin-hole position, arrange patterns, tamp drag solid, roll-over, take plate off, add cope half of pattern; use another drag with removable pins for cope of mold. Tamp solid, being careful to retain level sand parting surface; lift cope off, draw cope patterns, take pattern pins out or drive them back, replace patterns in cope mold. Apply medium touch of good shellac to evenly spaced sections of each half pattern-cope and drag. Set plate back in pin hole position on drag half, hold plate firmly to flask and roll-over; set drag with plate attached in pin hole position over cope, clamp or weight firmly, allow shellac time to dry to good pattern-retaining consistency; lift cope half of mold from plate and roll-over carefully. Lift drag half of mold from plate and pattern is mounted. Retention of position can be further secured by tacking pattern to plate with small brads. In all cases an identical relative position should be transcribed from the mold on the plate to avoid reverse position in assembling the molds made from the plate.

Permanent Mountings

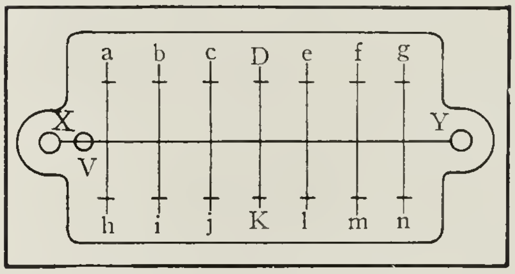
In mounting for permanency, metal patterns and plates should be used though wood patterns are sometimes permissable. The process is similar to that used in temporary instances except the means of securing the pattern. The pattern can first be secured with shellac, further secured by carefully soldering or clamping extreme points and then permanently secured with screws. The advantage of such a mounted plate is limited chiefly to hand molding. For all-around service the better plan is to use separate plates for cope and drag.

The execution of the separate plate idea is identical with that of the single in principle. It is more easily accomplished in that it permits a pin and hole flask to be used in making the mold, does away with the long double pin and offers better opportunities for securing the pattern. In mounting the larger patterns a very efficient plan is to dust parting on the mold, blowing it clean from the patterns, moisten the plate, set it on and lift it off thus getting an outline of the pattern positions. At judicious points, drill holes entirely through the plate, set the plate back and continue these holes into the pattern; lap the pattern holes for a machine screw, enlarge the holes in the plate to admit the screw freely, set the plate back on and screw the pattern tight. In pursuing this plan it is obvious that the mold should be rammed exceedingly hard and the drilling done by hand, approximately perpendicular to the planed surface of the plate. Along the line of this idea many variations can be reasoned out.

Obtaining mounted pattern from the sand impressions of the individual pattern, presuppose a minimum shrinking pattern compound to be melted and cast on the plate. Most of these compounds are expensive and in every case where size will permit adhere closely to lightening cores to reduce quantity. In accomplishing this we get the pattern outline on the plate as previously noted and paste and dry a reduced core reproduction of the pattern within these lines. The formula we use for this pattern compound differs from those we have recently seen given in *The Foundry*, though we have no reason to believe it any better and would recommend any of those given in the June issue for a good one.

In making the mold we use French sand for a facing, ram the mold solid, cut the gates and dry it. On the single plate calculate approximate pattern position as indicated in the accompanying illustration.

Draw an approximate center line *XY* and a perpendicular bisector, *DK*. Parallel to *DK*, draw line *ah*, *bi*, *cj*, *el*, *fm*, and *gn*; mark off equi-distant from line *XY* points *a*, *b*, *c*, *D*, *e*, *f*, *g*, *h*, *i*, *j*, *K*, *l*, *m*, and *n* and set the pattern over these points. Drill a ⅜-inch hole through the plate at these points and drill a ½-inch hole through the plate at *V* for the gate. In making the cope set the sprue over *V*, heat the plate slightly and assemble the mold with the plate in pinhole position, and clamp securely. In using a tin constituent compound it is often of advantage to *tin* the plate in the locality of the pattern occupation. Pour the compound into the sprue over point *V* allowing plenty of time in feeding the gate.



METHOD OF CALCULATING THE APPROXIMATE PATTERN POSITION

Sand Impression Plan

The separate plate sand impression plan can be reduced to a consideration of pattern retaining design. This opens up a wide field, as many methods can be pursued. We shall briefly note but three:

Tin the plate in space of pattern occupation.

Bore ½-inch holes through the plate at judicious points of pattern position, counter sinking on the opposite side of the plate.

Tap holes at judicious points of pattern position on the plate and screw T or cross-topped studs on the plate tapped holes.

Do anything to retain the cast pattern undisturbed in its mold position on the plate. In pouring the pattern mold, the flask is set with the mold side up, covered by the plate, into the gate hole of which the metal should be poured through a sand riser or head. When a countersunk hole is used in pattern retention, the metal can be left to rise in these holes and shrinkage fed in as it occurs, or they can be covered with cores firmly weighted down. Some of the neatest and most correct patterns we have were mounted in this way.

Patterns of depressed parting lines necessitate a depression in the drag plate and an elevation in the cope. This depression can be cast in the plate and a metal form identical in size and contour fitted in. This form can be worked out of a piece of metal or cast of white metal using the depression in the plate as an iron mold. It can easily be fitted to a level cope plate by drilling and tapping when the cope plate is fitted and clamped in pin-hole position to the drag plate, or can be cast on the cope plate by drilling two countersunk holes and pouring with the plates in this position.

Stripping Plate Additions

The stripping plate addition can be taken care of with little difficulty. The cope and drag stripping plate can be cast with openings to conform to the contour of the pattern halves. Clamped together with these pattern lines coinciding, they can be drilled on the jig and filed out a shade larger than the pattern halves. Slight draft should be given for the cast pattern. In making the drag of the mold the stripping plate should be in pin-hole position on the pattern plate. In casting or attaching to the pattern plate, the stripping plate sets between the pattern plate and the mold. In applying the stripping plate, care should be exercised to observe and file away any parts of the pattern line on the plate that may overlap those in the mold. In mounting the individual pattern, pieces of wood or metal can be used to take up the thickness of the stripping plate, being identical in contour with the pattern and attached to it in making the drag of the mold.

A few general suggestions follow:

Keep a set of true flasks and pins in good order and use for no other purpose.

Always heat plates before casting.

Plates with lightening cores should always be set on and lifted off to verify proper core position.

In taking relative positions, plates and flasks should be plainly marked to avoid confusion in assembling.

Two-pinned flasks with pins and holes in the center line of the flask seem to give best satisfaction.

The Influence of Occluded Gases in Cast Metal

A Discussion of the Action of Metal in Cooling Molds, and the Effect of Gases Upon the Phenomenon of Shrinkage

By J E Fletcher

THE precise constituency of molten cast iron and steel is, to a large extent, unknown. That it must contain in solution iron, carbon, silicon, manganese, phosphorus and sulphur, is known, but exactly how these metals and metalloids occur when in the liquid state cannot yet with absolute certainty be defined.

Our experimental evidence is gained from chemical analysis and microscopic examination from the solid material alone, but research has revealed the fact that the above named elements are largely present combined with one another, the constituents carbon and iron alone existing in the free state.

It may further be remarked that carbon and iron are usually found in both the free and combined state in all carbon-iron alloys, excepting perhaps that free carbon is not found in low carbon steels and iron in the pure state does not occur in the cast iron group.

These alloys solidify first and are followed by others in ordered succession. In cast iron, for example, the microscope reveals a constituent which is a mechanical mixture of iron carbide and iron, known as the eutectic, containing 4.3 per cent of carbon, and also another somewhat similar constituent containing 0.9 per cent of carbon, known as the eutectoid. Now, if quenching fixes the constituents present at the time of so doing, then the microscopic representation of the quenched alloy must resemble closely that of the virgin molten metal. The author has made many such experiments in the way of quenching various carbon iron and other alloys from the molten state and believes that there are definite structures even in the liquid metal itself.

It is unconventional perhaps to consider eutectics as existing above the temperatures of their melting points, but it is certain that the 4.3 per cent carbon eutectic can be superheated to 1,500 degrees Cent., which is the melting point of iron, and on being quenched will still reveal under the microscope a characteristic stratified honeycomb structure. The silico-ferrite crystallites under such circumstances are small, but of the characteristic fir tree or dendritic structure. It may be that there are liquid iron crystals as Quincke and Schenck have surmised, in a liquid matrix of eutectic composition and that these crystal forms and the eutectic structure are preserved by sufficiently brisk quenching from the molten condition. Gases are imprisoned or dissolved in all molten metals, and in cast iron and other eutectic-containing metals or alloys these gases are very probably the formative or directive element in the growth of the honeycomb-like formation of the primary eutectic. The flow line structure always having a direction towards the upper and hotters portions of the freezing mass of a eutectic ingot gives the impression of fine gas streams set in motion by convectional forces just as the streams of steam bubbles are given convectional flow in a boiler. It may be that the primary gas streams in flowing through the semi-liquid carbide of iron plate-like crystals make the paths through which the more or less carburized ferrite enters and freezes, such freezing action being immediately afterwards followed by that of the carbide.

Fig. 1 shows a pure eutectic iron quenched in iced brine after superheating to 1,500 degrees Cent., 370 degrees above its melting point. Fig. 2 illustrates a cast iron quenched from above the melting point, while Fig. 3 shows the same iron when slowly cooled down to the approximate temperature of the room.

The structure of a cast iron must have some relation to the primary structure it received in the blast furnace. The iron was reduced there from the ores, and descending became carburized by contact with the coke and carbon monoxide gas, the latter being the chief carbonizing agent. As it approached the hot zone of the boshes, it absorbed sufficient carbon to make a fusible alloy and in such state flowed down into the hearth having a composition approximately that of the eutectic and having by that time probably a distinctive structure. If this eutectic alloy has not ab-

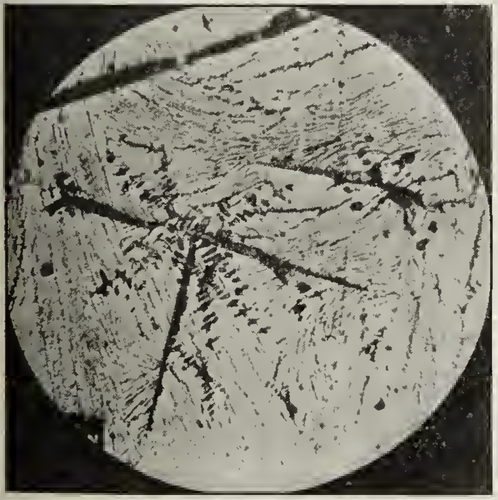


FIG. 1 — PHOTOMICROGRAPH OF A PURE EUTECTIC IRON QUENCHED IN ACID BRINE FROM 1,500 DEGREES CENT.

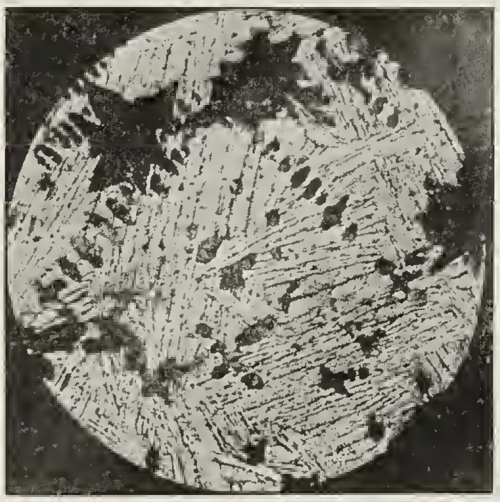


FIG. 2 — PHOTOMICROGRAPH OF A CAST IRON QUENCHED FROM ABOVE THE MELTING POINT

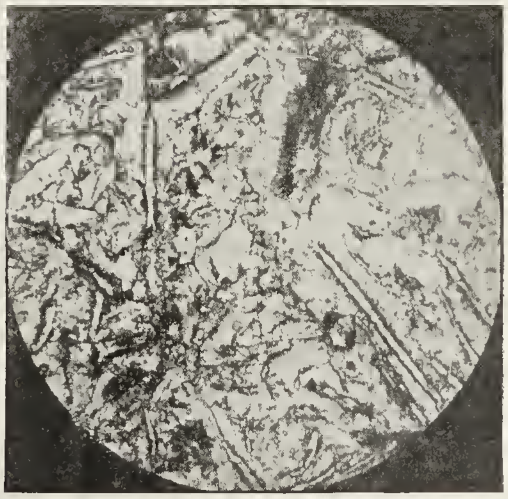


FIG. 3 — PHOTOMICROGRAPH OF THE SAME CAST IRON IN FIG. 2 WHEN SLOWLY COOLED TO ROOM TEMPERATURE

An abstract of a paper presented at a meeting on Nov. 27, 1916, of the Birmingham branch of the British Foundrymen's Association.

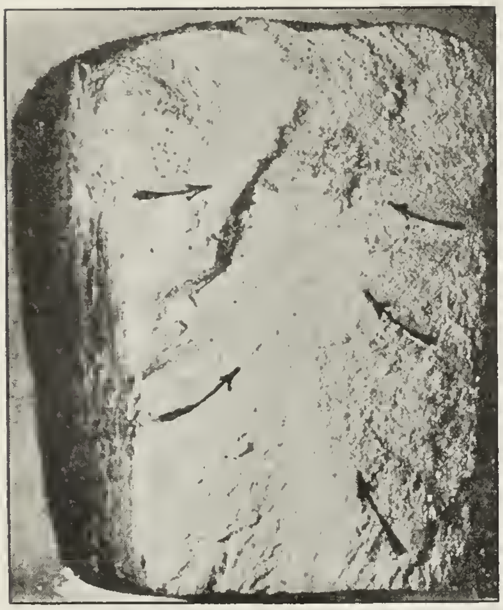


FIG. 4 — FRACTURE OF CAST IRON INGOT SHOWING THE DIRECTION OF THE PRIMARY CRYSTALS

sorbed enough carbon to become the true 4.3 per cent carbon eutectic or if it becomes bessemerized by the blast, then iron crystals are thrown into the eutectic and the structure has then the constituency of iron crystals plus eutectic.

These crystals become more or less carburized, but though they grow during the slow cooling in the casting bed, they preserve their entity, possibly permanently, since they may be found as part of the crystalline structure of a mild steel. Let us briefly consider the changes which take place during the reduction of the ore in the blast furnaces and further to the completion of the alloying period in the hearth. While the ores are being reduced, the oxides of silicon, manganese and phosphorus remain unaffected. During this period the iron oxides are attacked by the carbon monoxide gas, which is the principal reducing agent, as it is the chief carburizing medium. Now each particle of iron oxide must come into contact with the reducing gas or with the carbon of the coke. The latter contact cannot be so great a factor as is sometimes considered, since the coke descends in large measure unbroken into the hearth. It is well known that the reduction of the ore is accomplished by means of the gas CO; about 1.2 pounds of the gas CO_2 are set free for each pound of iron reduced. At the temperature of such reduction, say at 1,400 degrees Fahr., the volume of the gas is about three times its bulk at 60 degrees Fahr., hence it will be possible to prove that each pound of iron oxide, Fe_2O_3, in the ore when attacked by the gas CO liberates over 5,000 times its volume as CO_2 gas. It is not, therefore, difficult to imagine that as a result of such gaseous action the porous nature of the reduced iron is aptly called spongy. This may be called the first stage in the gas absorbing tendency of iron, for it is impossible to reasonably conclude that within the meshes of the spongy iron there can be freedom from gas imprisonment.

The presence of hydrogen in the gases imprisoned by this action is readily understood when we consider that the gases which attack the ores are a mixture of moisture evaporated from the blast, ores, flux and fuel; air; carbon dioxide gas from the decomposition of the limestone; and carbon monoxide gas, CO, produced by the incomplete combustion of the coke and liberated by the ore which is partly reduced by direct contact with the carbon of the coke.

The fracture of the metals conveys a great deal to the practiced eye, and an examination of the upper surface of cast iron as it runs into the pig bed and of its cooled exterior is often an index as to the effect of carbon, phosphorus and silicon. But the miscroscope is an invaluable and indispensable aid to the structure, as is the recording pyrometer to the behavior of the metal from its freezing point to the cold state. The use of the microscope, however, is an acquired art, which requires long practice and it cannot be too strongly urged that the effects of temperature, slow and rapid cooling, the influence of mass on the structure of cast iron and steel of many varying analyses be studied closely before the microscope can yield really useful results. Similarly the cooling curves taken from small samples may be misleading. Thus two small ingots of cast iron may be made from the same pig, one being carefully protected from oxidation during melting, the other free to surface oxidation. If such samples are melted and superheated to temperatures much in excess of their actual fusion point, the cooling or freezing point curves will be dissimilar, though there may be but little difference in the analyses of the two specimens. A low silicon pig iron was melted and the cooling curves taken were as shown in Fig. 5. The break in the curve *A* indicates the fact that the iron oxide formed during the superheating of the sample had partially oxidized the carbon of the carbide and had caused a separation of free iron crystals from the eutectic. This separation takes place at a higher temperature than that of the normal pig iron and is shown by the break in the curve at the point *P*.

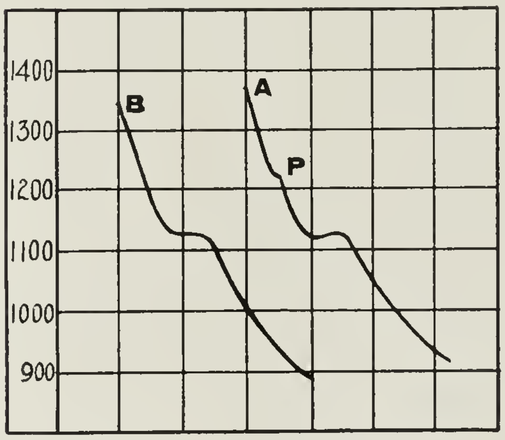


FIG. 5—COOLING CURVES OF LOW SILICON PIG IRON

In the study of the gas influence the principal use of the microscope is in tracing the difference in crystalline structure between the outer rapidly cooled and the inner slowly cooled zones of a casting. If the cooling curves are taken simultaneously at each of these zones, then in many cases the difference in the freezing behavior with its action on the phenomena of shrinkage and contraction may be observed. Thus in a high phosphorus iron there is considerable segregation of the phosphorus as phosphide eutectic towards the center of the casting mass and it is not unusual to find this reflected in the cooling curves taken from the exterior and the interior of the casting. The reason is, of course, that the higher phosphorus content of the interior lowers the freezing temperature at that point.

Just previous to freezing of cast iron or steel, the liquid metal may be conceived to consist of an agglomeration of liquid particles or crystals of iron more or less carbonized, silicide and phosphide of iron, carbides of iron and manganese, and of the sulphides of iron and manganese. Crystallites or fir tree shaped dendrites of partly carburized iron in the midst of a mother liquor which is made up of

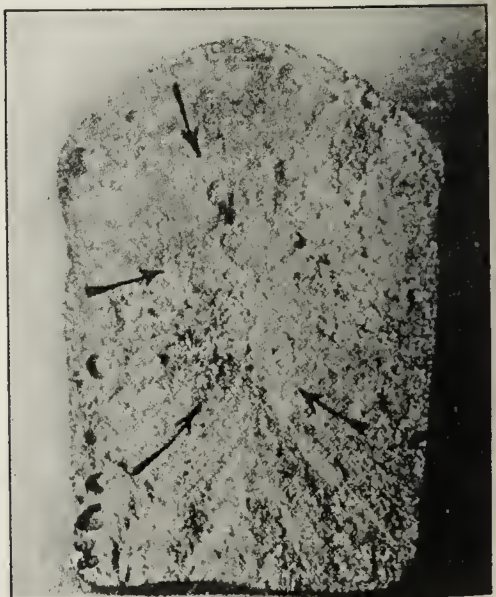


FIG. 6—FRACTURE OF CAST IRON INGOT SHOWING THE DIRECTION OF THE GAS STREAMS

carbide, phosphide, silicide and sulphide of iron, and of manganese carbide and sulphide, first separate out and freeze at the mold surface and at right angles to it. Almost immediately afterwards the silicide of iron freezes around the iron crystallites. These crystallites as they freeze eject their occluded gases which they originally contained, into the mother liquor or eutectic. As the iron or silico-iron crystals elongate and grow laterally, the gases are driven inwards, producing a flow of the mother liquor in that direction, toward the hot and fluid mass center. The volume of any such partially frozen portion of the metal is as follows: Primary crystals, A + mother liquor, B + ejected gases, C. As A increases, B decreases, while C simultaneously decreases. In cast iron the mother liquor B contains the segregate, slag, oxide and sulphide particles, together with the graphite flakes which escape with the gases into the hot fluid portions which, when frozen, contain the highest percentages of these impurities. The gases thus liberated travel to the hot zones in the castings which are the last to freeze. If there is no way for these gases to escape to the surface of the ingot or casting or by way of a riser, then gas cavities or pipes must occur. The function of feeding is, therefore, evident. As freezing progresses from the outside of a casting inwards, driving the gases to that point, unless a path is kept clear, and hot fluid metal can take the places of the gas bubbles or streams, gas cavities or spongy spots must remain.

Path of Ejected Gases

In a square ingot the crystals forming at the surfaces of the chill mold start freezing at right angles to the cooling surfaces. The crystals forming at the corners must meet one another in their growth and a plane of weakness is produced at each corner of the ingot. At the bottom of the mold crystals grow which in freezing meet the crystals growing from the sides and there is formed a pyramid whose surfaces are planes of weakness. Along these planes the ejected gases travel together with the segregates and slag particles, eventually reaching the central axis of the ingot through which they ascend to the ingot top. The action of the gases which escape into the mother liquor when the primary crystallites begin to form and grow, is much more important than has been generally considered. The natural tendency of the primary crystallites to grow at right angles to the mold side or chill surface is disturbed in many cases by the influence of the gas streams whose direction is always towards the point of easiest escape. This direction of flow is, of course, towards the hot fluid mass centers and naturally upwards. In a series of small cast iron ingots of taper form the direction of the gas streams and of the primary crystals is clearly seen in the fractured surface, as illustrated in Figs. 4 and 6. This surface when polished and etched was examined under the microscope and it was concluded that the curved lines of the fractured surface corresponded to the directions of the long axes of the primary crystallites and to those of the plate-like crystals of the eutectic.

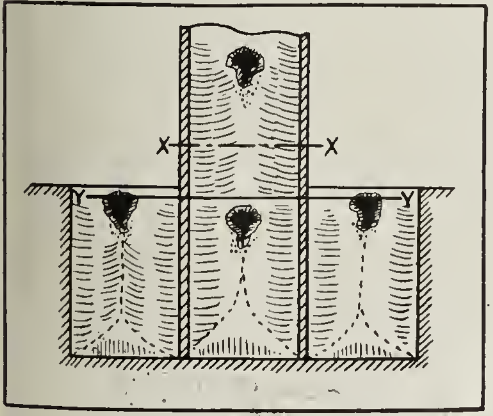


FIG. 7—ILLUSTRATING PIPING IN A GRAY CAST IRON BLOCK

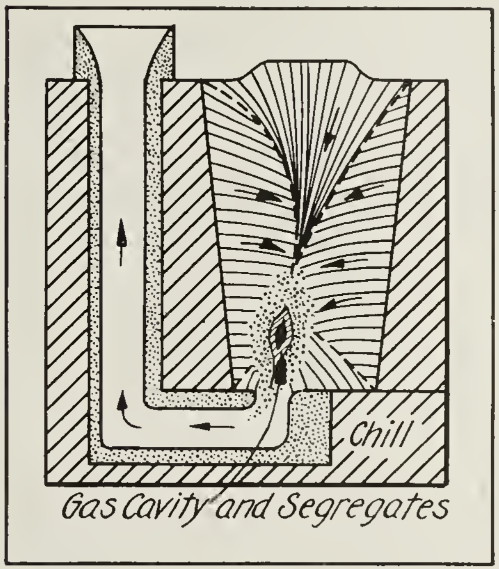


FIG. 8—SHOWING THE EXIT OF GAS TOWARDS THE VENT, AND THE DIRECTION OF THE GAS PATHS DOWNWARD

When there is no exit at the top of a casting whereby the liberated gases can escape, these will flow towards the vent wherever this is placed and in one case a downward flow was observed. A small ingot was run from the bottom through a trumpet runner as commonly used in the casting of steel ingots in closed top molds. The mold was first filled with molten slag, which was immediately afterwards displaced by molten-white cast iron. The result of the experiment, shown in Fig. 8, was that the gas paths ran downwards. In cast iron ingots the phosphide of iron and the sulphides together with the graphite liberated, travel along the planes of weakness, being assisted by the propelling motion of the escaping gases.

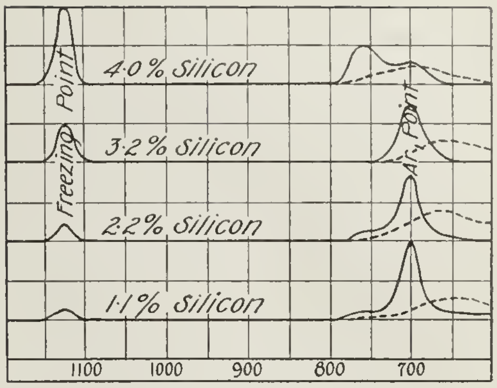


FIG. 9 — DILATION OF CAST IRONS; THE INFLUENCE OF 2 PER CENT MANGANESE IS SHOWN BY THE DOTTED LINES

Shrinkage is Vital Problem to Foundrymen

An important question arises in connection with the phenomenon of shrinkage. Is the phenomenon of shrinkage connected with the volume of occluded gases, or rather with that of gases escaping during the freezing of iron and steel? There are many evidences in favor of such a conclusion. A case in point was that of a mild steel block, which was cast from a ladle of well melted steel held in the ladle accidentally until close on the point of setting or congealing. The nozzle gave out and did not allow scarcely any steel to rise in the casting head or riser. When cold, the block was found to have contracted less than 1/16-inch per foot. The metal, when planed, revealed no pipe or cavity and was free from blow-holes. The weight of the casting indicated soundness. This case points to the fact that the gases escaped freely during the slow rising of the steel in the mold and that the occluded gases finally remaining in the metal mass were in a fine state of entanglement between the crystals, uniformly throughout the mass. A similar casting made in the same heat from a more fluid steel piped deeply in the rising head and contracted normally at the rate of 0.2-inch per foot.

In another case a gray cast iron cylindrical block was cast, in the center or axis of which was fixed an iron tube twice the depth of the block, as shown in Fig. 7. The molten iron was run into the mold surrounding the central tube or core. The iron tube was next filled with metal and the whole allowed to cool slowly. When parted near the upper surface of the block at YY the expected ring-shaped pipe was found in the outer ring, but the inner tube was found to be perfectly filled with metal which had not contracted. The inner ingot was again parted just above the block at *XX* and here again no contraction had occurred, though at the top of the inner tube or ingot there was a slight shrinkage. Two gas cavities were found in the inner ingot, one at the top and another almost opposite the top of the cylindrical block. The explanation would seem to be that the metal in the lower half of the inner ingot, being surrounded by a heated mass of the same temperature froze so slowly that it ejected its gases axially and upwards, the bubbles being perfectly replaced by liquid metal. Hence the lower half of the central ingot did not contract. The escaping gas met the bridge of congealed metal just above the block and was imprisoned, forming the lower cavity. The gases in the upper half of the tube escaped to the top, forming the usual pipe.

Whenever castings are made in chilled molds, there must be shrinkage or contraction. Under such circumstances, rapid freezing has a tendency to form small primary crystals which become quickly interlocked imprisoning small gas bubbles. The cooling of the mass causes a shrinkage of the gas bubbles and it has been concluded that each gas globule occupies much less volume at 60 degrees Fahr. than at 2,000 degrees Fahr.

Percentage of Composition and Shrinkage Per Unit of Volume of Iron

Combined carbon.	Graphite.	Si.	Mn.	P.	Volumetric contraction.	Class of iron.
0.45	3.33	2.8	1.2	0.8	1/135	Coarse gray
0.40	3.01	1.5	1.3	0.4	1/100	Light gray
0.95	2.35	1.0	0.4	0.7	1/77	Mottled
1.20	2.15	0.9	0.2	0.4	1/75	Mottled
1.50	2.10	1.0	3.2	0.5	1/58	White iron
5.00	0.20	0.7	11.2	0.1	1/50	Spiegel

Great strides have been made in the United States in foundry science in showing how volumetric change during the freezing and later cooling of iron varies with differing analyses. The clearest illustration of the relationship between the chemical analysis of cast iron and the behavior during cooling from the freezing point with the accompanying shrinkage has been given by Professor Turner. He has related the freezing and the shrinkage curves and in typical cases has shown that each grade and type of pig iron expands on freezing and shrinks in its own characteristic way. It was believed by Professor Turner with Messrs. Goe and Hague that when either silicon, manganese or phosphorus was added to a pure carbon iron, either singly or together, there was an expansion at the moment of freezing. In white cast iron containing about 3.5 per cent carbon and 96.5 per cent iron there is no such expansion, but a rather rapid shrinkage or contraction. The addition of silicon alone up to 3 per cent increases the expansion regularly and similarly the addition of manganese alone up to 2.5 per cent increases the primary expansion, the amount of such expansion per unit of the metalloid added being roughly the same in silicon as in manganese. Now when the two elements, silicon and manganese, are added to the 3.5 per cent carbon iron it is found that the primary expansion is increased and if a third element, phosphorus, is added, there is a further increase. In all cases, there is a halt in the rate of shrinkage and often a considerable second expansion when the recalescence point known as the pearlite point, is reached during the cooling down from the freezing or solidification point.

Just after freezing commences, when the primary fir tree type of crystals begin to form next to the mold surface, a certain amount of the iron carbide decomposes and is thrown out into the mother liquor as graphite flakes. This is one possible reason for the primary expansion. But when these silico-ferrite crystallites form they liberate a certain quantity of heat and at the same time eject a considerable volume of the gases which they held in solution when liquid. These gases, when thrown into the thin fluid mother liquor, would contribute to the expansion of the whole metal mass at that moment. When phosphorus is present, the mother liquor is made increasingly fluid and is capable of holding more gases in solution, permitting their ready flow. The gases then, as may be argued from the appearance of the micro-structure as quenched in this range of temperature, must be widely distributed as minute bubbles. At the point of recalescence there is another expansion generally, connected, as Professor Turner suggests, with the liberation of more free carbon or temper carbon, and probably with a further increase in the volume of the gases as a result of the heat evolution which then takes place. Baker in his experiments on the quantity of gases drawn off from iron and steel heated in a vacuum decided that the greatest quantity is ejected at the recalescence point, thus confirming the work of the earlier investigators, Troost and Hautefeuille, and Muller. More recently Charpy concluded that the expansion or dilation of carbon-iron-silicon alloys was increased at the freezing point as the silicon content rose, while the expansion at the recalescence point is diminished, as the plotted curves in Fig. 9 show. This conclusion confirms experiments made by the author on cast irons with varying silicon content some years ago, when it was further found that manganese and silicon together intensified such action. Generally speaking, white irons shrink most, the more highly siliceous irons shrink least. It is believed that silicon and aluminum tend to retain the gases in a fine state of division within the cooling mass, the decomposition of the carbide of iron is facilitated, graphite liberated with considerable evolution of heat, while the primary crystals are being formed or frozen. Hence gray siliceous irons solidify slowly and shrink least because of the occluded gases present in the mother liquor, which is the ideal condition for the free growth of the graphite flakes. It would seem that whenever the iron carbide in either the primary crystals or in the eutectic is retained, as is the case when manganese or chromium is present, the speed of freezing is increased and the gases liberated are driven rapidly into the more fluid portion of the metal mass where there is a tendency to form shrinkage cavities. In low silicon irons free from phosphorus, high manganese generally produces such results especially if the casting temperature is low. In the case of high manganese irons with high carbon content used in rapidly cooled castings the difference in the shrinkage rates between the outer freezing zones high in combined carbon and the inner zones of gray iron, not rarely results in pulls or draws in the outer skin. This is true especially in the neighborhood of internal corners where three planes meet. The presence of phosphorus is an aid to gas escape into the hot interior of a cooling casting. The increased fluidity given by reason of the fluid phosphide eutectic makes it easy to feed castings made from metal containing above 0.4 per cent phosphorus. The feeding process is really the means of supplying liquid metal to take the place of the gases which are being liberated as the primary crystals are growing at the expense of the gradually diminishing mother liquor. When by reason of low carbon content the constituency of a cast iron is steely in its nature then there is great danger of internal sponginess.

The question of hot casting, is, of course, allied with the problem of shrinkage and of gas exit. Generally it may be stated that when the metal is hot cast, when its molten temperature is higher than that necessary to simply melt it, the gases which are liberated during freezing are driven into the hot interior and as they escape to the risers, their place is taken by liquid metal. There is a better distribution of the gases which remain in the cold metal and less risk of blow-holes and gas cavities common with cold cast metals.

Hot Casting Permits Escape of Gas

With hot cast metal these gases are more uniformly distributed throughout the casting, a greater part escaping through the riserts or feeding heads. The importance of hot casting will be at once seen when dealing with pure irons of hematite and cold blast character, low in total carbon, phosphorus and silicon. Such iron cools and shrinks rapidly because its primary crystals freeze at a high temperature, and the mother liquor being more purely eutectic, freezes rapidly. Being difficult to feed, owing to the passage through the "pasty" stage, the gases pent up in the mass centers of the casting become frozen in and remain as shrink holes or gas cavities. Cast irons which are high in silicon and phosphorus do not suffer from the slow freezing of the eutectic. The mother liquor, which is a kind of compound eutectic, has a longer freezing range than the simple 4.3 per cent carbon eutectic. Moreover, during the freezing of the primary crystals the carbide of iron decomposes, graphite being liberated. The heat evolved keeps the mother liquor in a fluid condition and there is no "pasty" stage. Anyone who has observed the puddling of such irons will understand the difference between the behavior of a white refined iron of the old refinery plate type and that of a Lincolnshire gray pig iron. The latter is liquid for a much longer period than the former, and is most difficult to puddle, because the primary crystals remain for so long in an almost fluid state. Manganese retains the carbide in the eutectic and is an aid to rapid freezing. It also stiffens the primary crystals. It has a powerful effect in conjunction with silicon in suppressing the heat evolution at the pearlite point as the cooling curves show. It has been generally noticed that such suppression of the pearlite point, if accompanied by a lowering of the freezing point, indicates a tendency to rapid freezing of the primary crystals which are found to retain the austenitic condition even when slowly cooled.

With reference to the character of the gases occluded in iron and steel, a great deal of research work has been done, notably by Dr. Baker. Gases exhausted in a vacuum from cast iron and steel at temperatures in excess of 900 degrees Cent. have given the following analyses:

INCLUDED GASES IN IRON AND STEEL

	Per cent, by volume.
Carbon monoxide	45 to 50
Hydrogen	45 to 55
Carbon dioxide	0 to 5
Methane	0 to 3
Nitrogen	0 to 4

The importance of taking into consideration the influence of gases in the foundry problem can scarcely be underestimated. Unless efficient means are taken to secure the easy escape of gases liberated during the solidification of cast iron and steel, the occluded gases which remain entrapped expand again during the recalescence and may do further damage. The major portion of foundry troubles are associated to a certain degree with the question of included gases. The gases which are set free at the mold surfaces due to the driving off of moisture in the sand washes or molding composition or of volatile matter, belong to a different category and should, of course, be dealt with separately. The practical value of investigations is seen when the compositions of pig irons are compared with their shrinkage per unit volume during the cooling down from the freezing point to the temperature of the atmosphere. The figures shown in the accompanying table may be found useful in supplementing the observations which have been described.

Barlow Foundry Reorganized

The historic Barlow Foundry Co., Newark, N. J., the continuation of the business established by Seth Boyden, the originator of malleable iron, has been reorganized as Barlow Foundry, Inc., and will be continued. About three years ago the company built a splendid new plant at Newark, alluded to as a model by the state of New Jersey labor commissioner, but the cost of construction was not properly financed and this, combined with losses on account of poor business conditions in 1914 and the early part of 1915, resulted in the appointment of a receiver. The reorganized concern has an authorized capital of $250,000, of which $122,000 has been issued to creditors and stockholders in the old company. Also approximately $25,000 new capital has gone into the company. The officers are as follows: President, Walter Kidde, of Walter Kidde & Co., 90 West street, New York; vice president, Jos. Perrine; secretary and treasurer, Arthur E. Barlow. In addition to the officers, William Fellowes Morgan, president of the Merchants' Association of New York, and Samuel Dixon, of Wm. Dixon, Inc., New York, are directors. John Lawrence Carter, graduate of Stevens Institute of Technology, and formerly head of the efficiency department of the Hyatt Roller Bearing Co., Harrison, N. J., is the foundry manager.

Safety Awards Announced

The annual awards of medals to firms or corporations which have performed signal service in the promotion of industrial welfare and safety has been announced by the American Museum of Safety, 14 West Twenty-fourth street, New York. The Commonwealth Steel Co., of St. Louis, has received the Travelers Insurance Co. medal for protecting the lives of its workmen; the Julius King Optical Co., of New York, the Louis Livingston Seaman medal for the promotion of hygiene and the mitigation of occupational diseases as a result of its investigation of the effect of colored lenses worn by workmen; the Pullman Co., the Scientific American medal for developing the Dean end-frame for passenger cars to prevent telescoping, representing, in the opinion of the awarding board, the most efficient safety device invented within a period of years; the Anthony N. Brady medal to the Connecticut Electric railway, of New Haven, as the American electric railroad which has done the most to safeguard the lives of its men. The E. H. Harriman medal for the railroad which has made the best year's record in guarding the safety of passengers and employes is to be awarded later.

The offices of the Institute of Metals have been transferred to 36 Victoria street, London, S. W., because the Caxton House, former home of the institute, has been commandeered by the British war office. The new quarters include a reading room, library and a large assembly hall. The next meeting of the institute, known as the annual May lecture, will be given at the Institution of Civil Engineers, Great George street, Westminster, S. W., on Thursday, May 3. Prof. W. E. Dalby will speak on "Researches Made Possible by the Autographich Load-Extension Optical Indicator."

The Inspection of Bronze and Brass Castings

How Defects in Non-Ferrous Metal Castings Not Revealed by Surface Inspection May Be Discovered—Repairing Leaks and Preventing Cracks

By Ernst Jonson

BRASS and bronze castings are subject to various defects which are difficult to discover by surface inspection, or even by hydrostatic testing, when such a test is practicable. The defect which most commonly occurs results from the inclusion of oxide in the metal of the casting. This occurs in two ways: Either the molten metal contains an admixture of oxides, owing to insufficient protection of the molten metal from the air, or the dross from the surface of the crucible or furnace charge gets into the mold and is caught at some point where the flow is slight, and is thus prevented from coming to the surface in the risers.

In the former case the entire casting is bad, and the best way to discover this defect is to make tensile tests on specimens cut from a coupon cast from the same melt. The admixture of oxide is indicated most distinctly by the greatly reduced elongation, but also by low ultimate strength. The tensile test should therefore, be specified for all important brass and bronze castings, no matter whether a certain strength and elongation are of mechanical value or not. The metal in every important brass or bronze casting should have the strength and elongation typical of the mixture of which it is made as an evidence that the metal in the casting is clean. If a tensile test is impracticable, oxidation in the metal may be discovered by making a bending test on a machined specimen. The presence of oxide will then be indicated by a number of small cracks which open on the outside of the bend, and if the oxidation is extreme, also by the abnormal color of the surface of the fracture.

The writer's experience indicates that oxidation of metal in the crucible is a very common defect, especially of the mixtures of high percentage of copper, that is, of the bronzes. It is the writer's belief that in foundries where tensile or hydrostatic tests are not made, the metal is generally allowed to become considerably, and in many cases seriously oxidized in the crucible, because this defect in the metal does not show on the surface of the casting. To specify bronze castings merely by the mixture is therefore useless. Unless the metal is tested after it has been poured, one is not justified in assuming that it consists of a clean, uniform mixture of the ingredients put into the crucible, or even that the proportions of the mixtures are the same as originally made, for the proportion of one or two of the ingredients may have been decreased by oxidation. A bronze casting may be made of the correct mixture and may show no surface indications of defects, and still it may be nothing but a honeycomb of metal, the cells of which are filled with oxides.

Correct Molding Necessary

It is more difficult to discover the presence of included dross. If a hydrostatic test cannot be made, it is practically impossible to find such defects unless they happen to come to the surface of the casting, and even a hydrostatic test does not always discover such defects, because there may be considerable thickness of good metal along one or both of the surfaces of the casting. The best insurance against this kind of defect is correct molding, which strange to say, is very unusual. Poor molding, however, cannot be charged entirely to the foundryman. The designer is often equally at fault. The molding of a casting should be planned while the casting is being designed, and before its final shape is determined. Every brass or bronze casting should be designed with reference to a given position in the mold. The position being determined, the various parts of the casting should be so arranged that they are connected by a rising channel of increasing cross-section and with a minimum of offsets with one of the risers, which, of course, should be of much greater diameter than the thickest part of the casting. The chief reason for this rule is evident. The thinner the metal the sooner it solidifies; hence if a portion of the casting is separated from the riser by another part of the casting which is of less thickness, the metal in the heavier part of the casting would be fed by the riser only to the point at which the thinner connecting portion of the casting solidifies. After that the shrinkage will result in the formation of cavities in the heavy part of the casting. Chills may be used to some extent as a substitute for this arrangement, but only when a channel of increasing dimensions is impracticable.

When a casting is correctly designed with reference to molding, it is evident that there is much less likelihood of dross being caught in the mold, but that instead it will flow up into the risers. The foregoing presupposes, of course, that the pouring gate enters the mold at its lowest point.

Whenever practicable, castings should be poured from the bottom. There are certain castings which cannot be poured from the bottom, but it is a question whether castings poured from the top are ever quite free from dross. Hence, very important castings should be so designed that they can be poured from the bottom. Doing this will sometimes involve considerable expense, as the castings may have to be made much thicker than they need be, and perhaps, also, much machine work may be required to bring them down to the desired dimensions.

In determining the position of the casting in the mold extensive flat upper surfaces should be avoided, as dross may accumulate by being caught under the flat surfaces of the mold or core. When a flange forms the upper surface of the casting, it should be expected to contain some dross and an adequate amount of finish should be allowed so that this dross will be entirely removed in machining.

Inadequate risers constitute another source of trouble. A casting may be made in full accordance with the drawings and specifications, and yet contain deposits of dross which may cause it to fail under ordinary working conditions. These defects may be such that they would not be discovered by the most careful inspection, and even by a hydrostatic test. It is therefore unwise to leave the decision as to the number and size of risers to the foundryman who may be prejudiced by consideration of economy in favor of fewer and smaller risers than is consistent with the highest quality of casting. It would seem, therefore, that in specifying brass or bronze castings the total cross-section of the risers should be given in per cent of the greatest horizontal cross-section of the casting.

Brass and bronze castings are expensive to make, and it is therefore undesirable to reject such castings on account of defects which can be rem-

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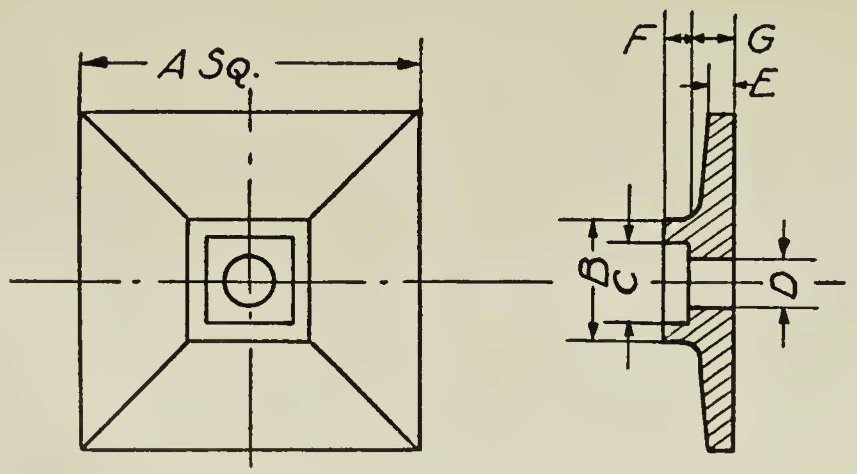
From a paper presented at the Cleveland meeting of the American Institute of Metals, Sept. 11 to 15, 1916. The author, Ernst Jonson, is engineer inspector, New York board of water supply.

THE FOUNDRY DATA SHEET, APRIL, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

STANDARD FOUNDATION WASHERS

By George W. Childs

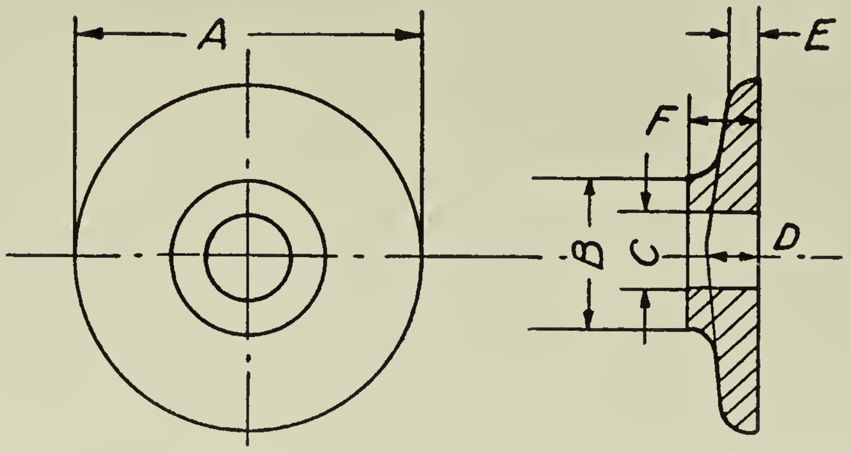


Diam. of Bolt	A	B	C	D	E	F	G	Est. Wt. Lbs. C. Steel
½"	5"	1½"	1 "	9/16"	⅜"	⅜"	⅝"	3.68
⅝	5	1 11/16	1 3/16	11/16	⅜	⅜	⅝	3.75
¾	6	1⅞	1⅜	13/16	½	½	¾	6.6
⅞	6	2 1/16	1 9/16	15/16	½	½	¾	6.6
1	7	2½	1¾	1⅛	⅝	⅝	⅞	11.
1⅛	7	2 11/16	1 15/16	1¼	⅝	⅝	⅞	11.
1¼	8	2⅞	2⅛	1⅜	⅝	⅝	1	15.2
1½	8	3¼	2½	1⅝	⅝	⅝	1	15.1
1¾	10	3⅞	2⅞	1⅞	¾	¾	1½	33.
2	10	4¼	3¼	2⅛	¾	¾	1½	33.
2¼	12	4⅞	3⅝	2⅜	⅞	1	2	60.6
2½	12	5¼	4	2⅝	⅞	1	2	61.
2¾	15	5⅞	4⅜	2⅞	1	1¼	2¼	107.8
3	15	6¼	4¾	3⅛	1	1¼	2¼	107.6
3¼	18	6⅝	5⅛	3⅜	1⅛	1½	2¾	182.9
3½	18	7	5½	3⅝	1⅛	1½	2¾	182.7

The Foundry, Data Sheet No. 231, April, 1917

STANDARD WOOD WASHERS

By George W. Childs



Diam. of Bolt	A	B	C	D	E	F	Est. Wt. Lbs. C. Steel
¼"	1¼"	⅝"	5/16"	3/16"	⅛"	¼"	.06
⅜	1⅞	⅞	7/16	5/16	3/16	⅜	.18
½	2½	1¼	⅝	⅜	¼	½	.42
⅝	3⅛	1½	¾	½	⅜	⅝	.83
¾	3¾	1¾	⅞	⅝	⅜	¾	1.46
⅞	4⅜	2	1	¾	⅜	⅞	2.14
1	5	2¼	1⅛	⅞	7/16	1	3.32
1⅛	5⅝	2½	1¼	1	½	1⅛	4.72
1¼	6¼	2¾	1⅜	1	½	1¼	6.06
1⅜	6⅞	3	1½	1⅛	½	1⅜	7.67
1½	7½	3¼	1⅝	1¼	9/16	1½	10.21
1⅝	8⅛	3½	1¾	1¼	⅝	1⅝	12.68
1¾	8¾	3¾	1⅞	1⅜	¾	1¾	17.35
2	10	4¼	2⅛	1½	⅞	2	24.9

The Foundry, Data Sheet No. 232, April, 1917

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

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edied. Minor leaks in hydraulic castings may be stopped by peening, but the fact that the casting leaked at a certain point generally indicates that the metal was defective at this point. It is commonly believed that certain brass and bronze mixtures are normally porous and permit water to pass through them under high pressure. This belief, however, is erroneous, at least up to a pressure of 1,000 pounds per square inch. If water comes through the walls of a casting even in very minute quantities under pressures which do not exceed 1,000 pounds, the metal is not clean, or the casting is porous from some other accidental condition. Peening is therefore a questionable method of treating defective spots in brass or bronze castings. If the defect is small and other circumstances permit, a hole may be drilled and a plug of the same metal as the casting may be screwed in. If plugging is not practicable or permissible, defective spots should be cut out by chipping or drilling so that all the defective metal is removed. It is difficult to determine just how much cutting should be done, because any cutting tool that may be used will cause the metal to flow sufficiently to cover up minor defects and make it appear solid. Etching with a mixture of ferric chloride and hydrochloric acid would probably reveal poor metal thus hidden by the rubbing of the tool. The cavity may then be filled by melting metal into it from a rod by means of a gas flame, or by pouring metal into it from a crucible. In either case this must, of course, be done in such a way that the entire surface of the cavity is melted and thus consolidated with the metal that has been added. It is known that when brass or bronze is stressed above the initial elastic limit and the full stress is maintained for a considerable length of time, it will fail by cracking, as soon as oxidation takes place on the surface. When a defective spot in a casting is welded, the cooling of the metal in the weld will be accompanied by contraction which will put a tensile stress in the metal of the weld as well as in the old metal which surrounds it. If the metal of the weld is the same as that of the casting its elastic limit may be appreciably higher than that of the rest of the casting, because the metal in the weld solidifies much more rapidly than that in the rest of the casting. The permanent deformation resulting from the shrinkage of the weld will therefore take place in the surrounding metal, and this metal will remain in a state of tension greater than its initial elastic limit. Later, cracks will appear. If the casting is of small lateral dimensions, and the ends are not constrained, and the break extends all the way across it, the stress set up in the old metal by the shrinkage of the weld is compressive, and therefore there is no danger of cracking. In all other cases shrinkage stresses must be prevented by keeping the casting heated to a very high temperature while the weld is being made and until it has solidified. The elastic limit of the surrounding metal will thus be temporarily lowered and the flow will take place under a stress much lower than the initial elastic limit of the cold metal, so that there will be no danger of cracking after the metal has cooled. Another way to prevent cracking is to anneal the casting immediately after the weld has been made. There is no reason to believe that the metal surrounding the weld is injured by the shrinkage stress until corrosion occurs on its surface. Therefore, if the elastic limit of the metal surrounding the weld is lowered by heating the entire casting to a sufficiently high temperature, additional flow will occur, and the cooling stress thus gradually reduced to a very small minimum according to the length of time the annealing is continued. The annealing temperature should be maintained for several hours so as to give the metal time to flow. Repairs of this kind should be made before any machining has been done, because the dimensions of the casting may be appreciably affected by the shrinkage in the weld as well as by the annealing. Castings which are subject to hydrostatic test should be given a preliminary test before any machining is done. A pressure of 100 pounds or less will generally be sufficient to reveal defects.

In machining brass and bronze castings trouble frequently arises from the fact that the patternmaker did not make proper allowance for minimum shrinkage. When a brass or bronze casting is constrained, shrinkage in the constrained direction is generally very much less than normal shrinkage. Core or other inside dimensions, which are tied up with outside machining dimensions, should therefore not be laid out on the pattern with a shrinkage rule, but with a normal rule. The designer can aid in preventing errors of this kind by marking over-all machining dimensions of castings "Must be Exact," when it is really necessary that they should be exact.

The Hardness of Copper Zinc Alloys

By Domenico Meneghim

IN ORDER to make determinations of hardness in order to ascertain the extent of cold working or of incomplete annealing, and being unable to utilize the classic method of Brinell, it occurred to the author to use a little apparatus operating under a slight pressure exercised by a ball of small diameter. Fig. 2 shows sufficiently clearly the arrangement of the apparatus. The pressure is brought to bear on the small piece of the alloy, which has plane and parallel surfaces, by a level along which weights can be moved. The steel ball, which will leave an imprint in the alloy, is fixed in a bronze cone. The specimen under examination must first of all be polished, and the imprint subsequently made by the pressure of the ball is afterwards measured under the microscope by means of a magnifying micrometer. For checking this apparatus, and for seeing if the superficial hardness had values comparable with those obtained from the apparatus of Brinell or of Shore, the author determined the hard-

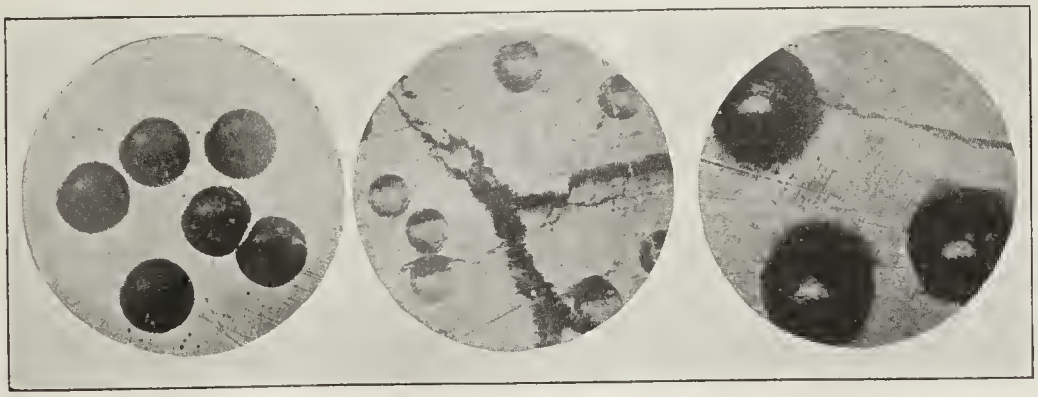

FIG. 1—HARDNESS IMPRESSIONS IN BRITTLE SPECIMENS OF THE SAME BRASS
The first specimen shows impressions in a sound portion. The second is a brittle fragment, and the hardness impressions are extremely irregular near the cracks. The third shows impressions after annealing, with a considerable dimunition of hardness. All are magnified 50 diameters. Their copper content is 64.1 per cent

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From a paper read at the September meeting of the British Institute of Metals.

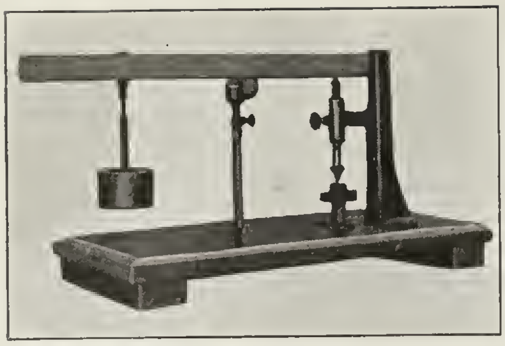


FIG. 2—INSTRUMENT FOR MAKING BRASS HARDNESS TESTS

ness of the copper-zinc alloys, of which there is in existence a complete diagram, given by Turner and Murray, obtained with the Brinell and Shore apparatus. The specimens were perfectly annealed, were then cut in pieces of about 70 millimeters in thickness. The alloys with zinc between 55 and 68 per cent were very hard and brittle, being most difficult to work.

Those alloys containing 78 to 88 per cent of zinc were in places very porous, and only in the case of samples containing 84 to 87 per cent of zinc was it found possible to obtain a specimen sufficiently homogeneous for making a hardness determination. The results are indicated as follows:

The determinations were made with a ball pressure of 10,870 kilograms (the diameter of the ball being 2.9 millimeters) in order to give an imprint lying between 0.280 millimeter and 0.570 millimeter. The superficial hardness is expressed as the ratio between the pressure exercised and the measured diameter of the imprint. For very hard alloys it was necessary to increase the pressure in order to obtain imprints lying between the values mentioned. In order to have all the hardness values stated for the same pressure, there were made for these very hard alloys three series of measurements at different higher pressures, and afterwards the diameter of the imprint at the normal pressure of 10,870 kilograms was worked out graphically. The diagram of superficial hardness is quite analogous to that given by Turner and Murray, only the first part of the diagram—that for brasses rich in copper—in less sinuous: perhaps that is due to the more perfect annealing of the specimens employed. It appears then that this very simple determination of superficial hardness can give in practice good results, which seem quite comparable with those obtainable with the much more costly apparatus, of Brinell and of Shore. This method has been utilized since for the study of gold-manganese alloys with very good results.

Results of Hardness Tests

No.	Copper per cent	Zinc per cent	Diameter of Impression, Millimeters	Hardness $\delta = \frac{P}{d}$.†
1	100.00	.....	0.560	19.4
2	94.15	5.85	0.522	21.8
3	87.17	12.83	0.495	22.0
4	79.81	20.19	0.492	22.1
5	77.80	22.20	0.462	23.5
6	75.20	24.80	0.482	22.5
7	70.05	29.95	0.511	21.3
8	67.31	32.69	0.513	21.2
9	64.50	35.50	0.516	21.0
10	63.82	36.18	0.533	20.4
11	60.48	39.52	0.492	22.1
12	59.23	40.77	0.456	23.8
13	54.45	45.55	0.389	27.9
14	51.89	48.11	0.380	28.6
15	49.54	50.46	0.361	30.1
16	45.20	54.80	0.247	44.0
17	42.51	57.49	0.162	67.0
18	33.65	66.35	0.150	72.5
19	29.19	70.61	0.250	42.0
20	27.54	72.46	0.290	38.0
21	25.84	74.16	0.296	36.8
22	22.85	77.15	0.365	29.7
23	22.05	77.95	0.386	28.2
24	15.13	84.87	0.454	24.0
25	9.63	90.37	0.437	24.9
26	8.33	91.67	0.447	24.3
27	4.25	95.75	0.456	23.8
28	3.60	96.40	0.465	23.4
29	....	100.00	0.685	15.9

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Wax-Finishing Bronze

We are completing a brass bank job which is to be wax-finished and we would like to know whether the wax is to be brushed or sprayed onto the surface. Also, is it necessary to heat the metal to impart this finish to the brass castings?

In applying the wax finish, first warm the bronze and apply the wax with a brush so as to coat the surface of the metal with a thin protective film of wax. Care should be exercised to have all portions of the metal thoroughly coated. The bronze should be heated sufficiently to melt the wax. A bronze plaque, oxidized and coated with wax in this manner 15 years ago, has the same appearance today as when it was first finished.

Refining the Grain of Brass

We make a line of locomotive castings, but the grain of the metal seems to be very coarse. The principal contents of the castings analyze approximately as follows: Copper, 76 to 78 per cent; tin, 6 to 8 per cent, and lead, 14 to 16 per cent. A 700-pound heat consists of engine scrap, 623 pounds; clean scrap copper, 70 pounds; tin, 7 pounds, and 1 pound of phosphor-copper. We would like to know how to refine the grain of this mixture.

The only way by which the grain of the metal can be improved is to resort to chilling the alloy, that is, by casting it in a permanent mold such as cast iron or steel. The effect is to check the crystal growth by reducing the time of its formation, which is afforded by slow cooling. If the permanent mold cannot be used, add 1 per cent of nickel to the alloy.

Melting With Coal Screenings

Can brass and other non-ferrous metals be melted successfully in a pit furnace with forced draft, using coal screenings?

We doubt very much whether brass can be melted with coal screenings even with forced draft. If the blast is sufficiently strong to penetrate the fuel, it is possible that sufficient heat may be generated to melt satisfactorily, but this only can be determined by test.

Tensile Strength of 88-10-2 Mixture

What is the greatest possible obtainable tensile strength of a mixture containing 88 per cent copper, 10 per cent tin and 2 per cent zinc? What method should be followed to obtain this high tensile strength and at the same time secure sound castings?

The greatest possible tensile strength that apparently can be obtained from an alloy consisting of copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent, is approximately 60,000 pounds per square inch, with an elongation of about 50 per cent. This tensile figure represents practically the high point, although from 52,000 to 53,000 pounds per square inch are frequently obtained with an elongation of 50 to 60.5 per cent. To obtain these high physical properties, it is essential to know how to melt the metal with the least possible amount of oxidation, what deoxidizer to use, to know how much of it to apply and when to add it to the mixture. This information is carefully guarded by manufacturers and is not easily obtained. Tests recently made on the 88-10-2 alloy by a number of concerns showed a tensile strength varying from 35,300 to 39,300 pounds per square inch, with an elongation of 10.5 to 13 per cent, which is much lower than the results previously given. However, this strength probably represents the average when the alloy is made without special treatment. The test bars should be cast to size and should be gated with a fin gate running along the side. To obtain sound castings, keep the metal well covered with charcoal while the melting operation is in progress.

Oxides in Ingot Metal

I have been having trouble with dirt on the outside of ingot metal castings of the following composition: 85 parts copper and 15 parts zinc, to which are added 20 pounds of yellow brass scrap and 2 pounds of lead. The dirt is on the outside of the castings and cannot be detected until the parts are machined. Can you advise us what causes this trouble?

We believe that the addition of 1 per cent of phosphor-tin will greatly aid in insuring clean castings. As a rule, dirt in metal is produced by oxidation and in fact, it is a mixture of oxides of the metals comprising the alloy suspended in the same. The metal can be cleaned by the addition of some agent, such as phosphorus, which reduces oxides to metal by robbing them of their oxygen; these, in combination with the phosphorus, become a fusible slag and rise to the surface of the metal, from which they can be removed by skimming. Occasionally, however, when yellow brass is made by melting emery grindings, the small particles of emery are held in suspension in the alloy and the brass, when polished, displays black spots similar to those found in aluminum castings. In this case the metal should be melted hot under a cover of a fusible flux, such as fluorspar or soda ash, to remove the emery particles.

Cheap Mixture for Locks

Kindly give me a brass mixture suitable for locks, hinges and latches that must take a high polish. What is the cheapest mixture that can be used, still obtaining a red appearance? Also, I am having trouble with trap covers due to pin holes or slag. Can you advise me the cause of this difficulty?

The following alloy will be satisfactory: Copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent, and lead, 5 per cent. Trap covers are noted for their trouble-making properties. To correct the pinholes, add 0.25 per cent manganese copper.

Color of Brass Castings

Will you kindly let us know the mixture of the sample of yellow brass forwarded under separate cover and how the color on the back or unpolished surface is obtained? We use aluminum in our mixture and the metal has a gray color. We would prefer the color of the sample, but cannot produce good results without the use of aluminum.

The color of the unfinished surface of the brass casting you mention is obtained by using a good grade of yellow brass free from aluminum. The same results can be obtained by using the following alloy: Copper, 70 per cent; zinc, 26 per cent; tin, 2 per cent, and lead, 2 per cent. This is a good grade of casting yellow brass and will produce much finer castings than the aluminum-treated metal, but it is a little more difficult to handle in the foundry.

Flux for Small Brass Particles

What is the best flux to use for melting small brass particles recovered from the cinder mill, magnetic separator, etc.? We would like to run this in ingot form.

The following flux will be satisfactory: Lime, 10 per cent; powdered fluorspar, 30 per cent; salt, 10 per cent, and soda ash, 20 per cent. This will make a liquid slag which will cause the small metallic particles to sink to the bottom of the crucibles.

Aluminum-Bronze Castings

We have an order for aluminum-bronze castings containing 90 per cent copper and 10 per cent aluminum, but thus far, we have been unable to obtain the tensile strength required by the specifications. Our risers and gates swell and mushroom a short time after the metal is poured. Different materials have been used for slagging and deoxidizing, but the results show no improvement.

As a casting proposition, aluminum bronze classes with such metals as copper, steel, nickel, nickel alloys and silicon-bronze, that is, it absorbs gases when molten and the castings are spongy unless the metal is treated with some element that has the power to remove these gases. The matter is complicated by the fact that the ordinary "deoxidizing" agents such as magnesium, vanadium, silicon, phosphorus, titanium, manganese, etc., that are efficacious in the case of the other metals and alloys mentioned, are quite powerless in the case of aluminum-bronze. The problem has been solved, however, and the method is in use by one manufacturer but cannot be given here. The use of the following precautions will materially assist in getting better castings. Melt the copper under charcoal; add a small portion of the aluminum first and note whether the surface of the metal becomes thick. If so, add a little salt and stir. This will act like zinc chloride on aluminum. Afterwards add the balance of the aluminum and if the metal is heated to incandescence, allow it to cool in the furnace to a normal temperature.

Tobin Bronze Mixture

Will you kindly give us a mixture for Tobin bronze, which will show an elongation of 20 per cent? We also have inquiries for bronze castings for gun carriages which must have a tensile strength of 28,000, 35,000, 45,000 and 60,000 pounds per square inch, respectively. No particular analyses are specified. Will you kindly give us formulas for bronze which will meet these requirements?

For Tobin bronze make an alloy which will analyze as follows: Copper, 60.35 per cent; tin, 0.79 per cent; zinc, 38.85 per cent, and aluminum, 0.01 per cent. The elongation will vary from 30 to 40 per cent, depending upon how long the alloy is allowed to flare while in the furnace. Cast the first melt of metal into ingots and remelt it for castings.

An alloy containing copper, 80 per cent, and tin, 20 per cent, will meet all of the requirements of tensile strength mentioned in your inquiry except the 60,000-pound specification for which manganese bronze should be employed. An excellent formula for this was given on page 72 of the February, 1917, issue of *The Foundry*.

Anti-Friction Metal

We are experiencing some difficulty with babbitt metal which analyzes as follows: Lead, 84 to 87 per cent; antimony, 12 to 14 per cent, and tin, 1 to 2 per cent. The chemist who made this analysis claims that the mixture also contains a substance which he terms "black oxide of lead". We would like to know what effect this oxide will have on the metal, relative to its wearing qualities as a bearing for freight and passenger car service.

If the alloy in question contains black lead in suspension, its bearing qualities will be greatly improved, as this substance will act as a lubricant. Black oxide of lead, however, is a substance that has been given little attention by chemists and metallurgists and some would even scoff at its existence. For freight and passenger car bearings, antomonial lead is most generally used as a lining metal. This alloy contains around 80 per cent lead and 20 per cent antimony. An excellent anti-friction metal is made as follows: Lead, 80 per cent; antimony, 15 per cent, and tin, 5 per cent.

How Walker Process Reduces Ingot Mold Costs

Collapsible Core and Hinged Cheek Flask Play Important Part in Novel Method of Molding—Stripping and Shaking-Out Operations Simplified

ON A par with the record-breaking steel production of the past 18 months has been the pressure on ingot mold foundries for castings. Many of these plants are allied departments of steel works, although it is estimated that more than 65 per cent of this tonnage is made in outside shops. Most of the ingot molds are poured from metal received direct from contiguous blast furnaces and in some instances these plants have a sufficient capacity to take the entire output from one or two stacks. A number of ingot mold shops remelt the iron in cupolas, this practice prevailing when it is impossible to obtain direct metal and when the direct metal is unsuited for these castings.

In the production of these bulky sections which aggregate a considerable percentage of the country's foundry production, the labor cost has been unusually high and every improvement in practice introduced in recent years has been directed toward the elimination of manual operations. Making cores for these large castings is a time-consuming operation and ramming the sand for the molds, in spite of the use of mechanically-driven rammers, is a back-breaking operation not favored particularly by molders, handy-men or laborers.

Recent Advances in Practice

Several years ago a collapsible core for ingot molds was introduced which greatly facilitates the shaking-out of the castings and also the production of the core. With probably only one exception, the molds continue to be rammed by hand, due to the difficulties experienced in ramming them by machine.

In connection with its Ensley blast furnaces, steel works and rolling mills, the Tennessee Coal, Iron & Railroad Co., Birmingham, Ala., operates a gray iron and steel foundry, the principal output of which, from a tonnage standpoint, consists of ingot molds. For a number of years these have been successfully rammed on a jar-ramming machine of the Mumford type, and this initial labor-saving operation was the forerunner of other experiments that had for their ultimate goal the production of the mold and core in one operation and the construction of all of the parts of the apparatus so that a crane or hoist can be employed in handling them. The only manual labor incident to the making of the mold and core and the shaking-out of the castings, involves the shoveling of the sand into the flask, and if sufficient headroom were available in this foundry, this operation could be eliminated by the installation of a sand chute.

The process was developed by J. B. Walker, superintendent of the pattern-shop of the Tennessee company

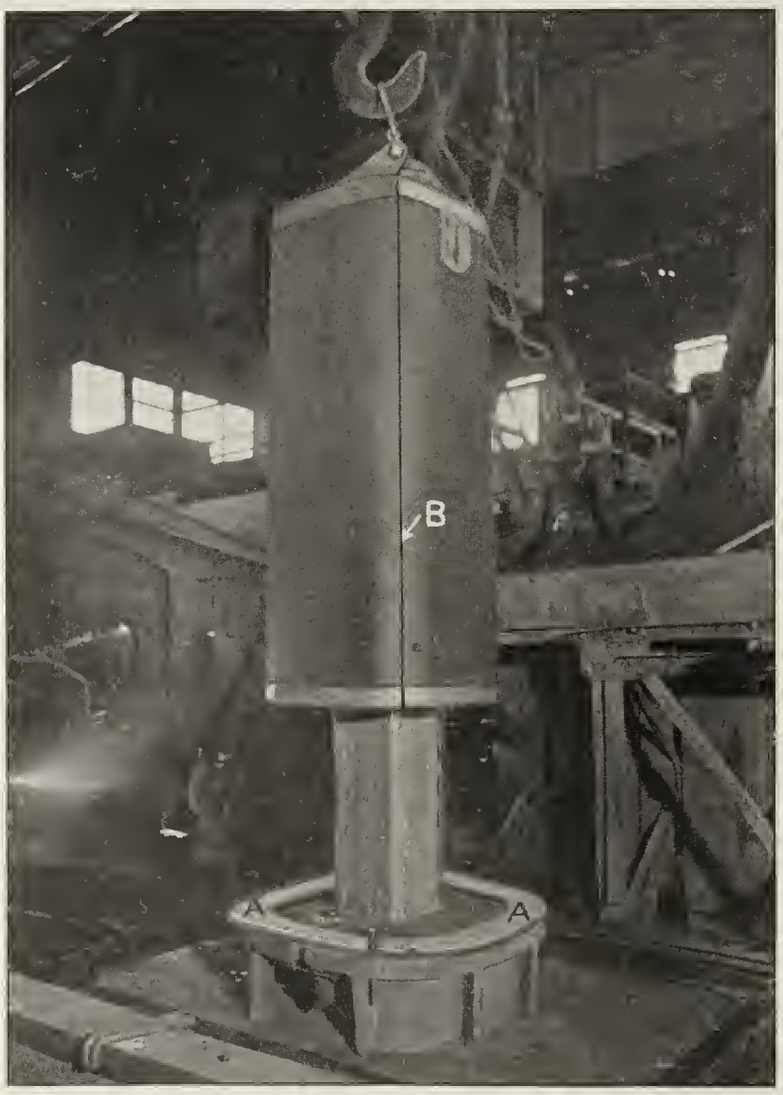


FIG. 1—LOWERING THE PATTERN OVER THE COLLAPSIBLE CORE ARBOR AND STOOL ON THE JAR-RAMMING MACHINE

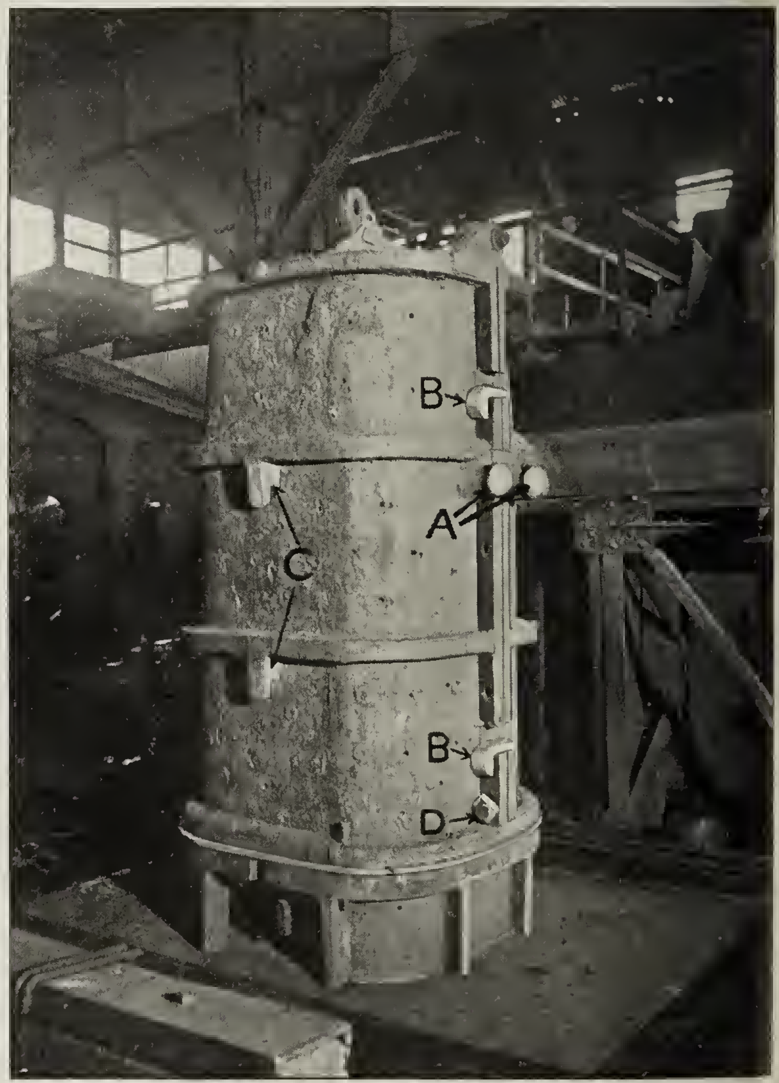


FIG. 2—THE CAST STEEL CHEEK FLASK IN POSITION ON THE STOOL OR DRAG WITH THE STRIPPING PLATE BETWEEN

and involves the making of the mold and core in one operation on a molding machine of the jar or jolt-ramming type; the use of a collapsible core, special hinged flask, core arbor and stool, stripping plate and a hinged pattern which expands automatically thereby stripping freely from the sand core when lifted by a crane.

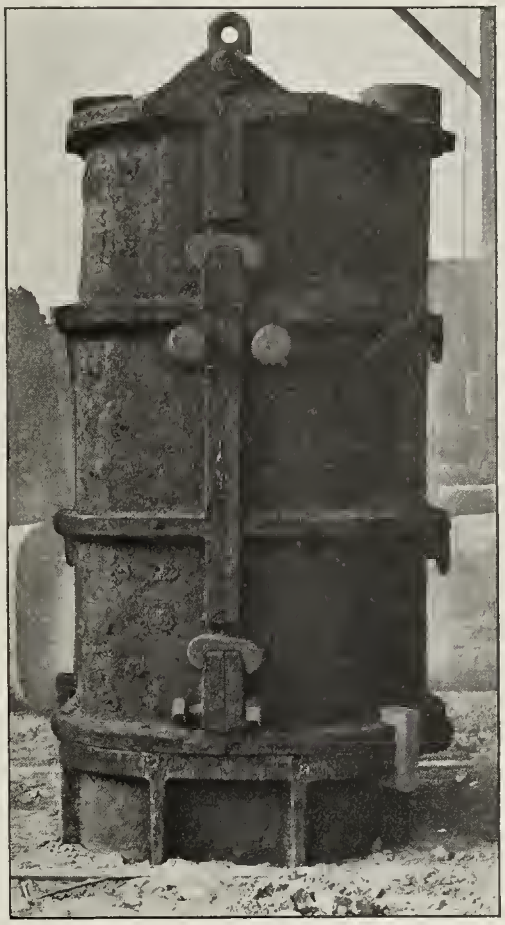
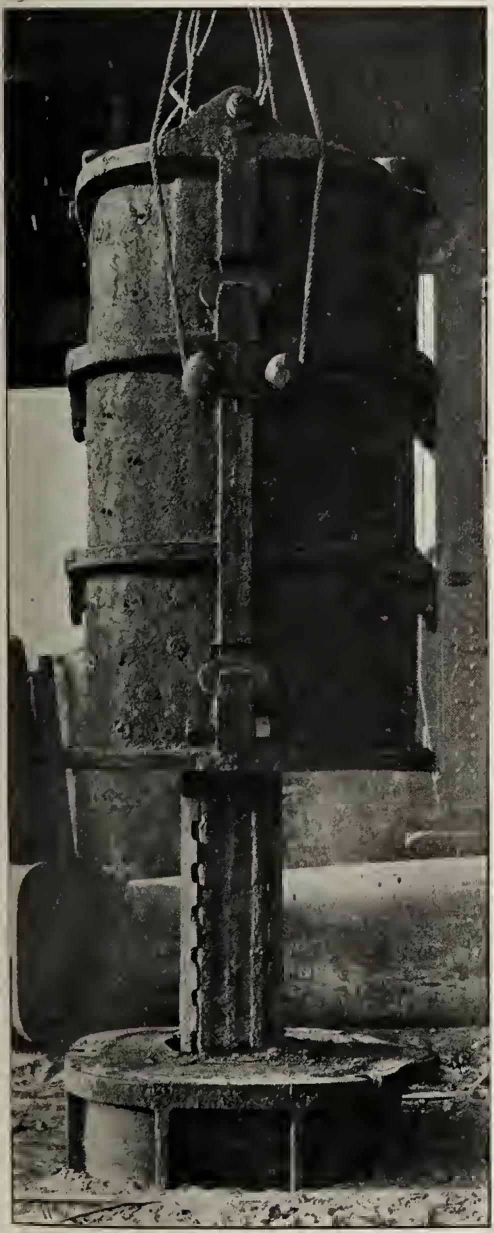


FIG. 3 — THE INGOT MOLD POURED AND READY TO BE SHAKEN-OUT

Sequence of Operation

Before describing the apparatus in detail, the sequence of operation entailed in assembling the flask, drawing the pattern, finishing and closing the mold, pouring and shaking-out will be presented. In the accompanying illustrations, the 40,000-pound jar-ramming machine is shown in Figs. 1 and 2. The core arbor and stool, with pattern being lowered into position, are illustrated in Fig. 1. On the parting surface of the stool is shown the stripping and lifting plate, *A*, which is centered by pins passing through holes in diagonal sides of the stool. The core arbor and stool constitute the drag section of the flask. The pattern is hinged at the top, being split across diagonal corners, as at *B*, thereby leaving it free to expand when it is being lifted off the core by a crane or hoist. The cheek section of the flask is shown lowered onto the drag or stool, in Fig. 2. The stripping plate is clamped to the cheek on two opposite sides, while the cheek is clamped to the stool, on the remaining two sides. The cheek flask consists of two parts hinged at the top. The bearing surfaces of the halves are brought together by the rope sling on the crane which loops over lugs or trunnions, *A*, Fig. 2, located on either side of the flask. When brought together by the crane, the two halves are locked by U-shaped clamps, *B*, Fig. 2. The lugs, *C*, two on each half of the cheek flask, are engaged by the crane sling when shaking-out the casting, Fig. 5, to effect the spreading of the two halves of the cheek and bolt, *D*, Fig. 2, has been provided to limit the distance of opening.



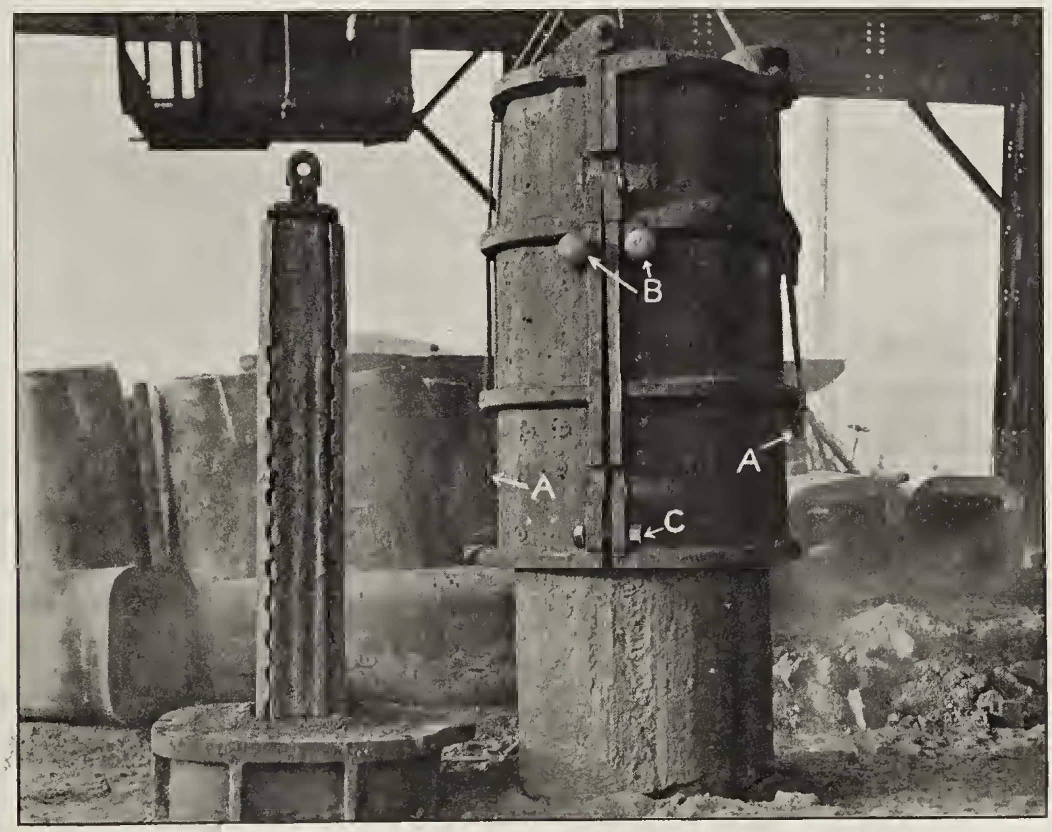


FIG. 4 (At the Left)—AFTER COLLAPSING THE CORE ARBOR, THE CHEEK FLASK CONTAINING THE CASTING IS LIFTED OFF BY CRANE—FIG. 5—THE HINGED CHEEK FLASK HAVING BEEN EXPANDED, IS READILY LIFTED OFF

Collapsible Core

The pattern is centered on the stool by the stripping plate and it is prevented from spreading by the bank of sand which packs around it after the initial jar-ramming operation. Before sand is filled into the flask, the collapsible core is expanded by a key at the top. Sand continues to be shoveled into the flask throughout the ramming operation on the machine, which consumes from 10 to 12 minutes. After the mold and core are rammed, sand is shoveled out of the mold top on two sides and the two loose parts of the pattern which make the ingot mold lugs are attached to the pattern body by a tongue and groove, and the sand is packed around them by hand. One of the difficulties heretofore experienced in making ingot molds on a jar-ramming machine has been the inability to properly pack the sand around these parts of the pattern. The sand underneath the lugs invariably was soft and rammed-off, causing an imperfect coating. However, by inserting the pattern lugs after the ramming operation has been completed, the sand underneath the surface of the lugs is of the proper density and all previous difficulties have been overcome. The runner, which is a 3-inch steel bar, is withdrawn by the crane before the flask is removed from the machine table.

Casting Pit Operation

From the jar-ramming table the mold is transferred to the casting pit by crane where the pattern is drawn and the cheek and core are skin-dried and sprayed with blacking, after which they are assembled for pouring. After removing the clamps which hold the cheek and the drag, the cheek is stripped over the pattern which is held down by a special device to overcome the great pressure of so large a body of sand on such an extensive pattern area. In the meantime the stripping plate continues to be clamped to the cheek, but when the cheek part of the mold is stripped from the pattern, the latter being hinged at the top is free to expand at the bottom and it opens at two diagonal corners. The pattern is next drawn from the core by the crane. In the meantime another stool and core arbor have been placed on the table of the jar-ramming machine and the pattern is lowered into position for preparing another mold. Whatever finishings on the cheek and core are necessary are performed in the pit, after which they are sprayed with blacking and skin-dried. The drying continues for a period of about 12 hours and before the mold is assembled and closed, the stripping plate is removed. A gate, 3 inches in diameter, is cut at the bottom of the runner by the molder who does the finishing. A pouring basin is set on top of the mold, the metal entering through one gate only, at the bottom.

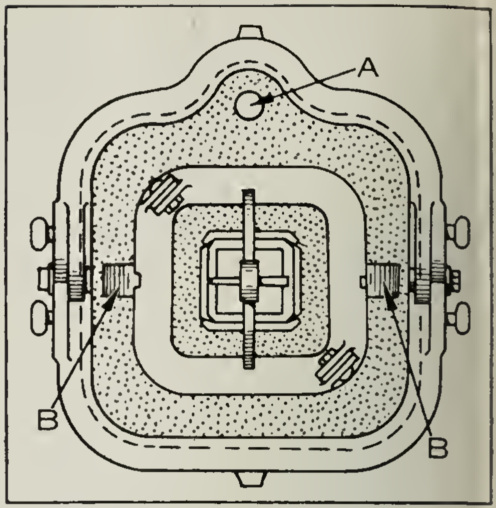


FIG. 7—TOP PLAN VIEW OF THE ASSEMBLED APPARATUS

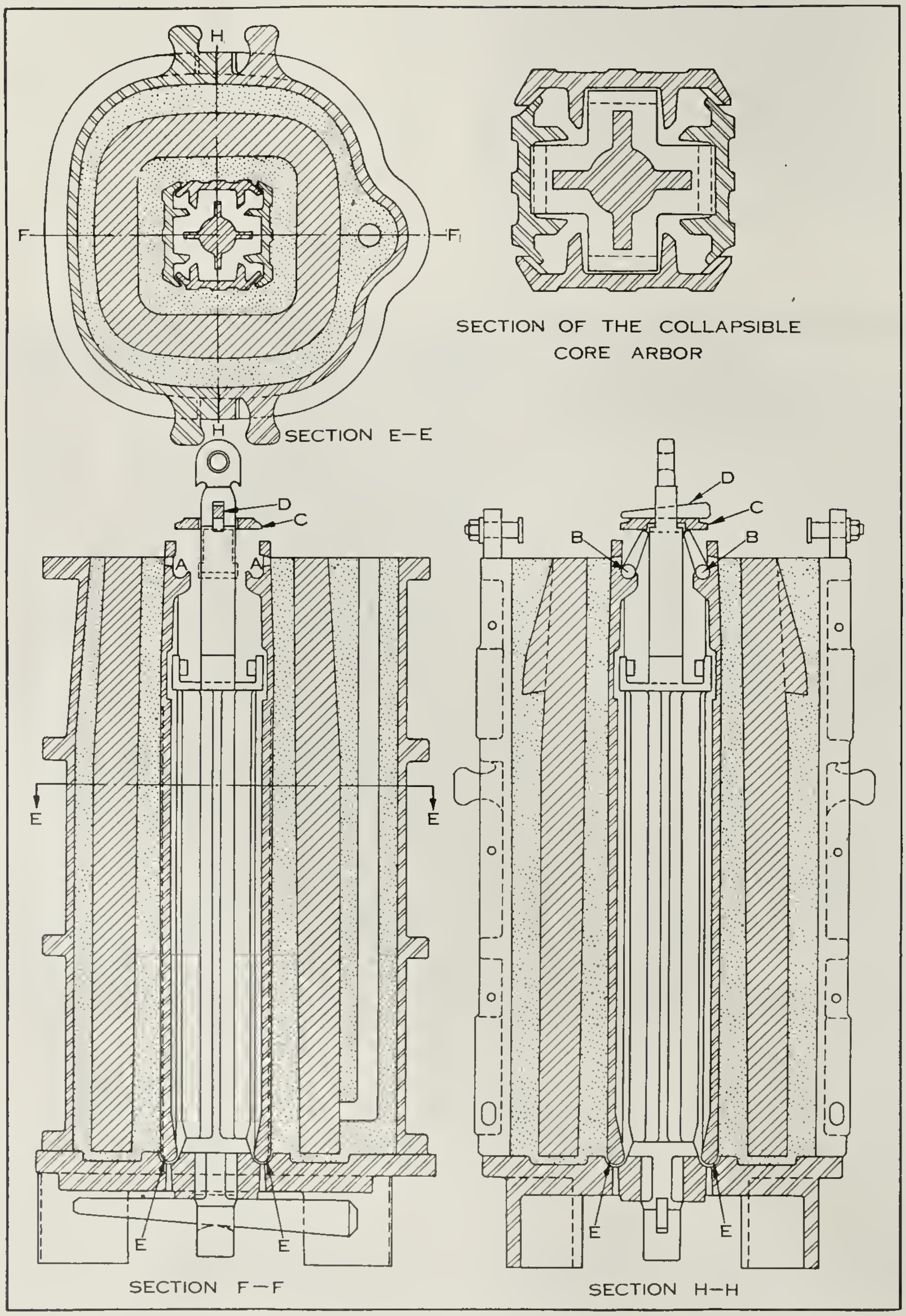


FIG. 6—HORIZONTAL AND VERTICAL SECTIONS OF THE ASSEMBLED APPARATUS AND HORIZONTAL SECTION OF THE COLLAPSIBLE CORE ARBOR

Shaking-Out

After the mold has been poured, it is conveyed by crane from the pit to the shaking-out floor, Fig. 3. The rope slings on the crane pass over the trunnion lugs on either side of the flask, Fig. 4, which shows the first step in the shaking-out operation. Prior to removing the cheek flask, the key at the top of the core arbor by which it was expanded, was punched out, thereby permitting the arbor to collapse and making it possible to lift the cheek from the arbor. In Fig. 5, the arbor collapsed and the stool are shown at the left. At the right the cheek flask is being stripped from the casting, leaving the sand adhering to the outside of the ingot mold, the same as the sand of the core remains inside of the mold when stripped over the core arbor. By permitting the casting to remain surrounded with the core and molding sand until it cools, it becomes thoroughly annealed, which has been found to be a particularly desirable operation for ingot molds, materially increasing their period of usefulness.

When stripping the hinged cheek flasks from the mold, the crane sling engages the opening lugs at *A*, Fig. 5, *B* being the closing lugs or trunnions. The U-shaped clamps previously have been removed and

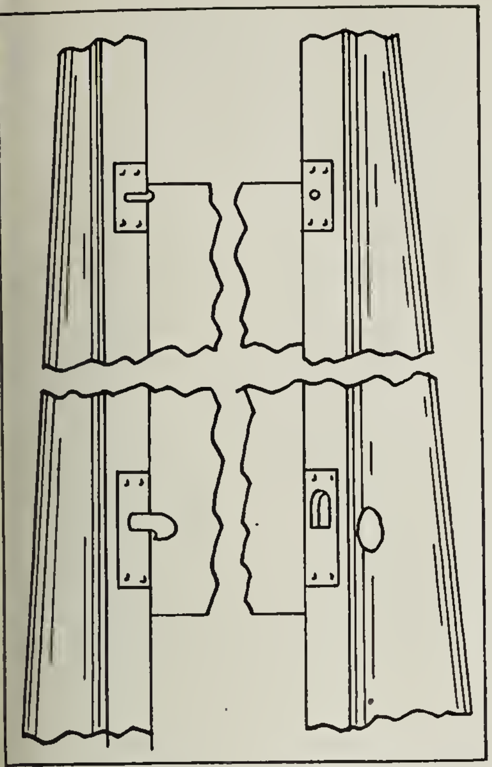


FIG. 8—DETAIL OF THE TOP OF THE EXPANSIBLE CORE ARBOR

the lateral action of the slings permit the flask to open the distance provided by the bolt *C.*

In Fig. 6 are shown vertical and horizontal sections of the assembled apparatus, with a section through the core arbor. The arbor is formed by four collapsible staves which carry at their upper ends internal socket bearings, *A,* Fig. 6, in which pawls, *B,* are mounted free to rock, being disposed upwardly so as to engage the column of the arbor at a point above the top of the staves. The staves have lapping corner joints, as illustrated in the section of the arbor, Fig. 6, and their construction also is clearly shown in Fig. 12. The staves are expanded by the action of the plate, *C,* and the wedge key, *D,* on the column, which engages the pawls and forces the staves outwardly until arrested by the engagement of the lugs on the staves with stop lugs on the column. At their lower ends, the staves are mounted to rock in the sockets, *E,* on the stool drag. The stool is recessed in its upper face to form the drag portion of the mold.

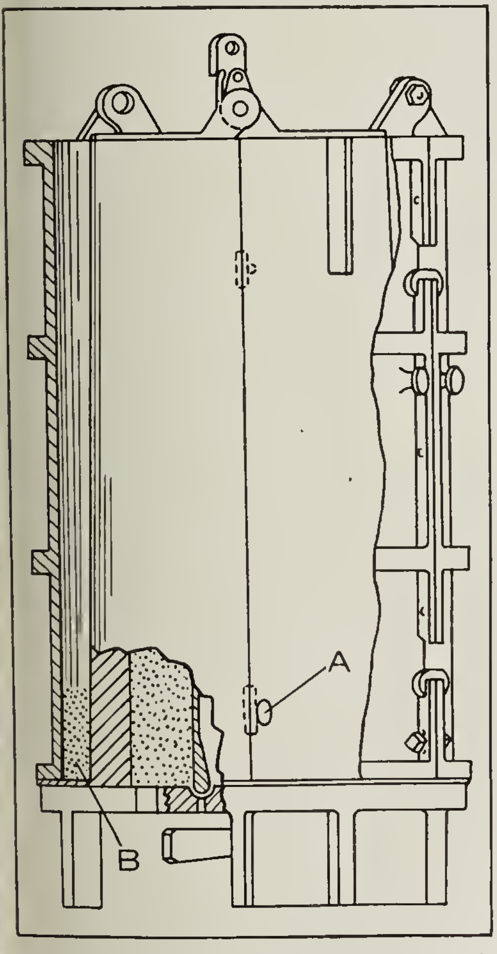


FIG. 9 — ELEVATION OF THE FLASK BROKEN AWAY TO SHOW EDGE OF PATTERN AND SAND BAND FOR HOLDING IT CONTRACTED

An elevation of the flask broken away to show the edge of the pattern and illustrating the sand band for holding it contracted during the ramming operation, is illustrated in Fig. 9. The pattern is divided diagonally in a vertical plane and each section carries about its top a protecting plate with upturned, perforated lugs at each end, arranged to overhang so that their holes, when in register, will lie in the plane of parting between the pattern sections. Between each pair of lugs is interposed a hanger plate which is on the same bolt that pivotally connects the lugs. The upper ends of these plates have holes to receive the hooks of the crane. The two holes of the pattern are centered by dowel pins and the expanding movement of the two sections is limited by an ingenious arrangement of hooks at *A,* Fig. 9, and shown in detail in Fig. 11. The encircling sand band is to hold the pattern contracted, as illustrated at *B,* Fig. 9. When ramming a mold, sand first is shoveled between the pattern and the flask to a height of about a foot. The table is given three or four jolts which compact the sand around the pattern and force and hold together the free ends of the section.

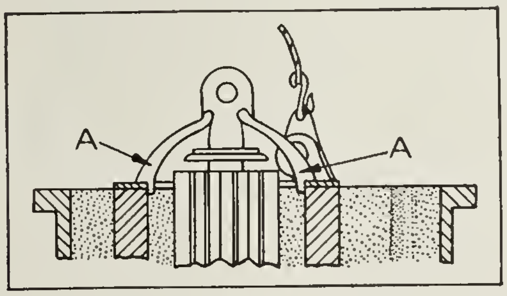


FIG. 10—DETAIL VIEW OF THE APPARATUS FOR HOLDING DOWN THE PATTERN AND THE METHOD OF APPLYING THE CRANE HOOKS TO THE PATTERN

Fig. 7 is a top plan of the assembled apparatus showing the gate at *A* and the detached lug patterns at *B.* As stated previously, it is practically impossible to pack the sand around these lugs by the jolting or jarring process, and this mold and core are rammed before the ingot mold lugs are attached to the pattern. The operator removes the packed sand from the top of the pattern when the lugs are to be attached and inserts the lug patterns into vertical slots in the pattern which engage tongues in the lugs. The lug patterns are stripped off with the cheek and are drawn as a part of the finishing operation. A review of the device used

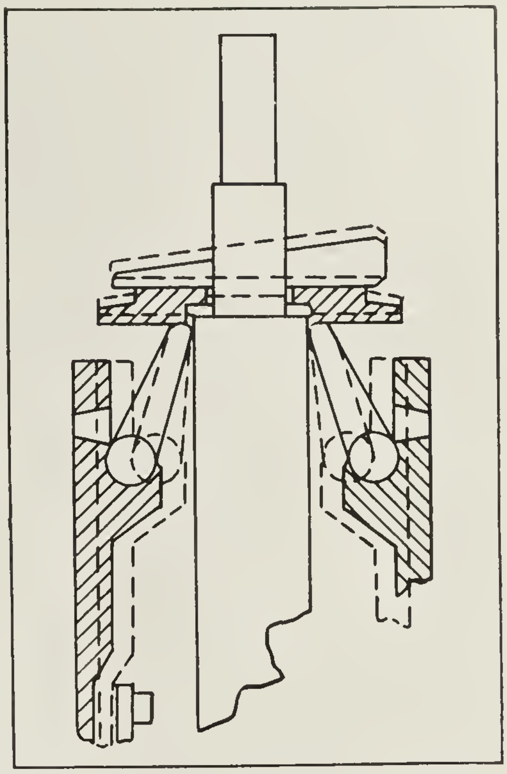


FIG. 11—DETAIL OF THE PATTERN DOWELS AND HOOKS

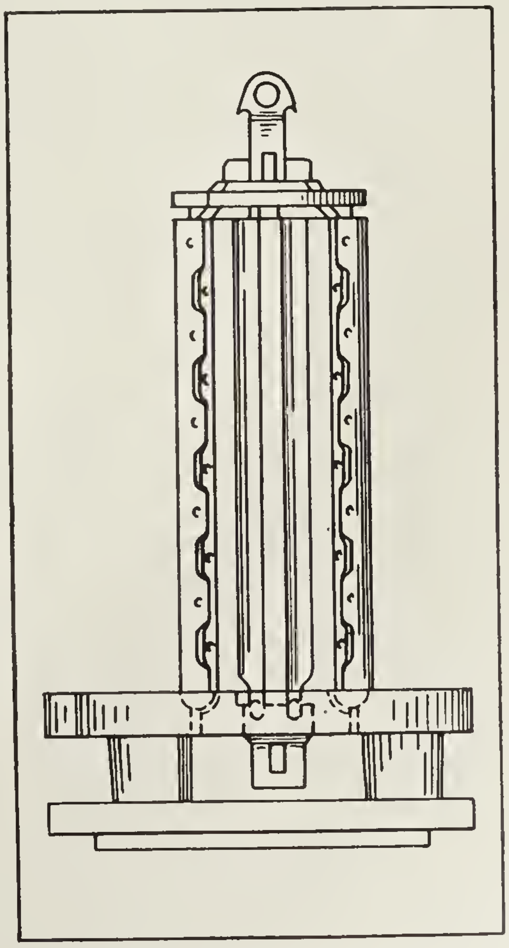


FIG. 12—THE CORE ARBOR SHOWING THE CONSTRUCTION AND ARRANGEMENT OF THE PLATES

for holding down the pattern when drawing the cheek and the manner of applying the crane hooks to the pattern, is illustrated in Fig. 10. Bars, *A*, are inserted between the lugs of the arbor column and the inner wall of the pattern and prevent it from moving upwardly when the cheek is being stripped from the stool, drag and pattern.

The Tennessee Coal, Iron & Railroad Co. uses unusually large ingots in its blooming mill. These are 24 x 24 inches and weigh approximately 10,500 to 11,000 pounds. The entire flask equipment, core arbor, etc., necessarily must be very heavy and when ready to pour, the mold for the ingot mold weighs 21,200 pounds. The flasks are cast steel and are made in this foundry. The coring of vent openings in the flasks has been eliminated by the arc-welder, which burns these holes in the flasks much more speedily than the cores can be set in the mold. The ingot mold core is thoroughly vented through the plates, the gases being carried off at the top. Green sand, tempered with water only, is used for both mold and core. Twelve molds are made daily by a gang of 10 men consisting of the following: Six laborers, one rammer, two finishers and one man who closes the molds and pours the castings.

One of the great difficulties that had to be overcome in successfully adopting the jar-ramming operation to the production of these large molds, was the prevention of the movement of the flask on the table of the machine. After careful investigation it was ascertained that this was caused by the leakage of air between the piston and the anvil of the machine which imparted a slight tilting motion to the table. A male and female joint were machined on the two surfaces which are thoroughly packed, thereby preventing the leakage of air and all creepage of the flasks has thereby been eliminated.

The Ingot Mold Mixture

The metal made by the Tennessee company's blast furnaces is not adapted for use in ingot molds, and, therefore, the direct process is superseded by the cupola method. The mixtures are made in a 54-inch furnace which is driven continuously from about 8 a. m. until 4 p. m. The heats vary from 75 to 80 tons, and considering the diameter of the lining the practice is unusual. However, the method of charging is so controlled and fluxes are used so judiciously, that a hang practically never occurs. The metal used for ingot molds has the following analysis: Silicon 1.5 per cent; sulphur, 0.06 per cent; phosphorus, 0.2 to 0.3 per cent, and manganese, 0.60 to 0.65 per cent. The life of these molds varies from 75 to 90 heats.

The Pattern Maker of the Hour

By Joseph Goostray

Many problems enter into patternmaking which give ground for careful consideration and exceptional opportunities for careful study. It is a trade requiring not only the ability to read mechanical drawings and a knowledge of the durability of woods and the ease with which they are pared and worked, but also a thorough understanding of foundry practice.

Foundry practice is such a comprehensive study that a knowledge of it in its entirety cannot be demanded of a patternmaker. However, it is proper to insist that he be thoroughly familiar with the process of molding and coremaking. There are a few points which should be emphasized and constantly kept in mind because of their significance in the relation of pattern-making to foundry practice.

Satisfactory patterns are necessary for efficient molding and they should always be constructed to effect the greatest economy in the foundry. It is doubtful whether the average foundryman realizes to what extent a patternmaker can go in the construction of cheap patterns. The patterns may perhaps meet requirements and a careful inspection may show the dimensions are accurate. The critical question, however, is whether the patterns afford facility of operation for the molder. The construction of a pattern with the view of the best methods of molding it should be one of the first considerations. A properly constructed pattern will save a lot of unnecessary work and expense in the foundry to say nothing of the subsequent delay in the production of castings.

Few patternmakers are familiar enough with molding and core-making to realize the problems which confront the molder and coremaker. Unfortunately many patternmakers do not know whether a pocket or hanging portion of sand will stand of its own accord. If the molder is forced to secure parts which could be easily formed by a core, his operations are considerably delayed. Special care should be exercised by the patternmaker to eliminate difficulties that might enter into the making of a mold. Such knowledge is only acquired by observing the consequences of molding a particular pattern. A patternmaker should keep in touch with what is being done in the way of improved molding methods. This is necessary if the pattern shop is to serve its best interests in its relation to the foundry, but it is very much more important to the patternmaker as a means of broadening his views and knowledge of foundry practice. Too much emphasis cannot be placed on the absolute necessity of a patternmaker going into the foundry and making an honest and efficient effort to observe the methods used in molding and coremaking. Only in this way can he gain an insight into the attendant problems of molding and coremaking. Knowledge gained through experience brings with it conviction.

There is also a tendency among patternmakers to confine their study of machines to those used in making patterns. This tendency is decidedly wrong, for a patternmaker cannot do his best work unless he is familiar with molding machines. He should study the adaptability of these machines for he can assist materially in promoting their efficiency and usefulness. His patterns should be constructed after a careful study of the various machines so that the limit of output may be attained when the pattern goes into the foundry. The argument that a pattern must be tried out is weak. Notwithstanding the points that may be advanced to substantiate the argument, it has been proved beyond a doubt that a properly constructed pattern needs no special foundry trial to determine whether it can be molded to its best advantage.

Furthermore no patternmaker can accomplish much without a thorough knowledge of the applications of cores. Many distinct advantages may be secured, and the appearance of a casting greatly improved by the application of cores. It is essential for a successful patternmaker to be thoroughly acquainted with this phase of foundry work.

An endeavor to find a simple definition of the application of cores results as follows: Cores are used to form the portion of a casting which is not determined by the pattern or in many instances they are used to form the whole of the casting.

How much of the casting shall be formed by cores and how much by the pattern cannot be determined by any definite rule, but is a question to be decided by a constant study of the methods employed in making castings of this nature. Experience and observation are necessary to determine the question but books are admirable adjuncts. Of course mere reading in itself would never make a patternmaker, any more than reading without actual experience would make a practical man in any field of work. But the patternmaker who carefully reads and studies journals pertaining to the foundry is far more apt to be able to determine this question than if he had not. Through reading he will not be so liable to fall into the error of thinking his is the only and best way to accomplish the required results. Undoubtedly he will gain through reading the experience of others who have had a similar problem to solve.

Recommends Standard Screen Scale for Sieves

Bureau of Standards Announces Scale Based Upon Ratios of Square and Fourth Roots of Two—Proposed for General Adoption

AS THE result of investigations and conferences held over a period of several years, the bureau of standards has announced a standard screen scale for testing sieves. The standard has been adopted by a conference of representatives of government bureaus, private firms and various scientific and technical societies including the American Foundrymen's Association and American Institute of Metals. The standard scale is recommended for general adoption in the interests of securing uniformity of usage.

The screen scale is essentially metric. A sieve having an opening of one millimeter is calculated as a basis of the system. The sieves above and below this in series are related to it by using the square root of two (1.4142) or the fourth root of two (1.1892) as a ratio of the width of one opening to the width of the next smaller opening. The ratio is used for openings between one and eight millimeters, while the fourth root of two is used for the ratio of openings below one millimeter.

The bureau of standards announces that it will test sieves to determine whether they conform to the specifications covering the new standard. The cost of testing ranges from $1 to $2 per sieve, depending on the number of sieves submitted for examination at one time. Only one-half of the fee is charged for examining sieves which are rejected for exceeding tolerances of mesh.

The specifications for sieves conforming to the standard screen scale are as follows:

Wire cloth for standard sieves shall be woven (not twilled, except that the cloth of 0.062-millimeter, the 0.052-millimeter, and the 0.044-millimeter sieve, may be twilled until further notice), from brass, bronze, or other suitable wire and mounted on the frames without distortion. To prevent the material being sieved from catching in the joint between the cloth and the frame, the joint shall be smoothly filled with solder, or so made that the material will not catch.

The number of wires per centimeter of the cloth of any given sieve of the standard screen scale shall be that shown in the accompanying table in the column headed "Mesh", and the number of wires in any whole centimeter shall not differ from this amount by more than the tolerance given in the column headed "Mesh" under the heading "Tolerances". No opening between adjacent parallel wires shall be greater than the nominal width of opening for that sieve by more than the following amounts:

10 per cent of the nominal width of opening for the 8 to the 1-millimeter sieve, inclusive.

25 per cent of the nominal width of opening for the 0.85 to the 0.29-millimeter sieve, inclusive.

40 per cent of the nominal width of opening for the 0.25 to the 0.125-millimeter sieve, inclusive.

60 per cent of the nominal width of opening for the 0.105 to the 0.044-millimeter sieve, inclusive.

The diameters of the wires of the cloth of any given sieve shall be those shown in the column headed "Wire Diam." and the average diameter of the wires in either direction shall not differ from the specified diameter by more than the tolerance given in the last column under "Tolerances" headed "Diam."

The bureau of standards also reserves the right to reject sieves for obvious imperfections in the sieve cloth or its mounting, as, for example, punctured, loose or wavy cloth, imperfections in soldering, etc.

Until further notice, to permit the use of sieves now on the market which have slightly different mesh and wire diameters from that specified above, sieves will be certified as satisfactory if the measurements of mesh and wire diameters show the resulting average width of opening to be within 4 per cent of the

Proposed Standard Screen Scale for Sieves

Dimensions for metric scale are given in millimeters; those for customary scale are given in inches

				Ratio Wire diam. to	Tolerances (plus or minus)	
Standard	Opening	Mesh	Wire diam.	opening	Mesh	Diam.
8-mm Sieve:						
Metric	8.00	1.0	2.00	0.25	0.01	0.08
Customary...	0.315	2.54	0.079	....	0.03	0.003
5.66-mm Sieve:						
Metric	5.66	1.4	1.48	0.26	0.01	0.08
Customary...	0.223	3.56	0.058		0.03	0.003
4-mm Sieve:						
Metric	4.00	2.0	1.00	0.25	0.02	0.05
Customary...	0.157	5.1	0.039		0.05	0.002
2.8-mm Sieve:						
Metric	2.83	2¾	0.81	0.29	0.02	0.05
Customary...	0.111	7.0	0.032		0.05	0.002
2-mm Sieve:						
Metric	2.00	3.9	0.56	0.28	0.04	0.05
Customary...	0.079	9.9	0.022		0.1	0.002
1.41-mm Sieve:						
Metric	1.41	5.0	0.59	0.42	0.08	0.025
Customary...	0.0555	12.7	0.0232		0.2	0.0010
1.0-mm Sieve:						
Metric	1.00	7.0	0.43	0.43	0.15	0.020
Customary...	0.0394	17.8	0.0169		0.4	0.0008
0.85-mm Sieve:						
Metric	0.85	8.0	0.40	0.47	0.2	0.015
Customary...	0.0335	20.3	0.0157		0.5	0.0006
0.71-mm Sieve:						
Metric	0.71	9.0	0.40	0.56	0.3	0.012
Customary...	0.0280	22.9	0.0157		0.75	0.0005
0.59-mm Sieve:						
Metric	0.59	10.0	0.41	0.69	0.4	0.012
Customary...	0.0232	25.4	0.0161		1.0	0.0005
0.5-mm Sieve:						
Metric	0.50	12.0	0.33	0.66	0.4	0.012
Customary...	0.0197	30.5	0.0130		1.0	0.0005
0.42-mm Sieve:						
Metric	0.42	14.0	0.29	0.69	0.6	0.010
Customary...	0.0165	35.6	0.0114		1.5	0.0004
0.36-mm Sieve:						
Metric	0.36	16.0	0.26	0.72	0.6	0.010
Customary...	0.0142	40.6	0.0120		1.5	0.0004
0.29-mm Sieve:						
Metric	0.29	20.0	0.21	0.72	0.8	0.010
Customary...	0.0114	50.8	0.0083		2.0	0.0004
0.25-mm Sieve:						
Metric	0.25	23.0	0.185	0.74	1.0	0.008
Customary...	0.0098	58.4	0.0073		3.0	0.0003
0.21-mm Sieve:						
Metric	0.21	27.0	0.16	0.76	1.0	0.008
Customary...	0.0083	68.6	0.0063		3.0	0.0003
0.17-mm Sieve:						
Metric	0.17	31.0	0.15	0.88	1.0	0.008
Customary...	0.0067	78.7	0.0059		3.0	0.0003
0.14-mm Sieve:						
Metric	0.14	39.0	0.116	0.83	1.0	0.008
Customary...	0.0055	99.1	0.0046		3.0	0.0003
0.125-mm Sieve:						
Metric	0.125	47.0	0.089	0.71	1.5	0.008
Customary...	0.0049	119.4	0.0035		4.0	0.0003
0.105-mm Sieve:						
Metric	0.105	59.0	0.064	0.61	2.0	0.008
Customary...	0.0041	149.9	0.0025		5.0	0.0003
0.088-mm Sieve:						
Metric	0.088	67.0	0.061	0.69	2.5	0.005
Customary...	0.0035	170.2	0.0024		6.0	0.0002
0.074-mm Sieve:						
Metric	0.074	79.0	0.053	0.72	3.0	0.005
Customary...	0.0029	200.7	0.0021		8.0	0.0002
0.062-mm Sieve:						
Metric	0.062	98.0	0.040	0.65	3.5	0.005
Customary...	0.0024	248.9	0.0016		9.0	0.0002
0.052-mm Sieve:						
Metric	0.052	110.0	0.039	0.72	4.0	0.004
Customary...	0.0021	279.4	0.0015		10.0	0.00015
0.044-mm Sieve:						
Metric	0.044	127.0	0.035	0.80	5.0	0.004
Customary...	0.0017	323.0	0.0014		12.0	0.00015

nominal opening of the given sieve, and the ratio of wire diameter to opening of the sieve in question is within 0.03 of that given in the column headed "Ratio Wire Diam. to Opening" for the 8 to the 2-millimeter sieves, inclusive, and within 0.06 of the ratio given for sieves of smaller openings than 2 millimeters.

Provision has been made for interpolating between screens of 8.0 to 1.0-millimeter openings by using the fourth root of two as the ratio of successive sieve openings. This would provide sieves of the following openings: 1.19, 1.68, 2.38, 3.36, 4.76 and 6.72-millimeter.

To provide for sieves of larger openings the screen scale could be extended from the 8-millimeter size in the accompanying table to 128 millimeters. Such an addition to the scale would provide sieves of the following sizes, based on the ratio of the square root of two; 11.3, 16.0, 22.6, 32.0, 45.3, 64.0, 90.5 and 128.0-millimeter.

Casting Production in 1916

From figures compiled by the American Iron and Steel Institute, covering the total pig iron production in 1916, a fair estimate can be obtained of the casting production of the United States last year. The production of foundry iron reached the enormous total of 5,553,644 tons, to which 921,486 tons of malleable iron must be added. It is difficult, of course, to estimate the casting production for 1916, since no statistics are gathered covering this industry. The high consumption of scrap is a factor which must be considered in this total, but it can be estimated safely that the total casting production last year was well in excess of 7,000,000 tons. With the malleable pig iron production approaching the million-ton mark, the growth of the malleable industry can fairly well be gaged. The 1916 production of foundry iron increased 14 per cent over that of 1915.

Oliver J. Abell has resigned as western editor of *The Iron Age* to engage in business for himself as a manufacturer's agent, with offices in the Sharples building, 565 Washington boulevard, Chicago. Mr. Abell will specialize on equipment for handling material and the transmission of power, including a full line of chain for elevating, conveying and power-drive purposes. Mr. Abell is a graduate of Case School of Applied Science, Cleveland, and has had extensive experience in trade journalism and in the iron and steel business. He is a member of the Chicago Foundrymen's Club, American Foundrymen's Association and the American Iron & Steel Institute.

The Use of Cast Iron Molds and Cores

By Paul R Ramp

CAST IRON cores and molds frequently effect great economies in core-making and molding. Some foundrymen, however, do not consider this method of molding favorably and for this reason the use of cast iron cores and molds is not extensive. Unfortunately, cast iron cores are not always properly used. An iron core should not be used in parts of molds where the metal will hold it so firmly that it will have to be driven out of the casting. It is also inadvisable to use a cast iron mold for making castings that are to be machined, unless a low chilling iron is used. To produce castings in permanent molds means must be provided for removing them from the molds as speedily as possible. The joints of the mold should also be kept clean and these joints should be machined to prevent the formation of fins. The permanent mold effects undoubted economies and many sections now cast in sand could be produced in this way. Cast iron cores can be used extensively, except in such sections of molds that contain projections that will hold the core. In the accompanying illustrations the use of cast iron cores and molds for various castings is shown. Two views of a locomotive grate frame are illustrated in Fig. 1. In ordinary practice cores are used to form the journals, *B*, as well as the bearings for the rocker grate, *C*. Unless great care is exercised in making these cores, both bearings will be unusually rough. By the use of cast iron cores at these points, smooth surfaces can be obtained and as they are chilled they can be subjected to considerable wear. The lug, *E*, Fig. 1, is generally formed by a large core which extends down from the upper part of the pattern. This core is expensive to manufacture and considerable trouble is frequently experienced in holding it in place, as it

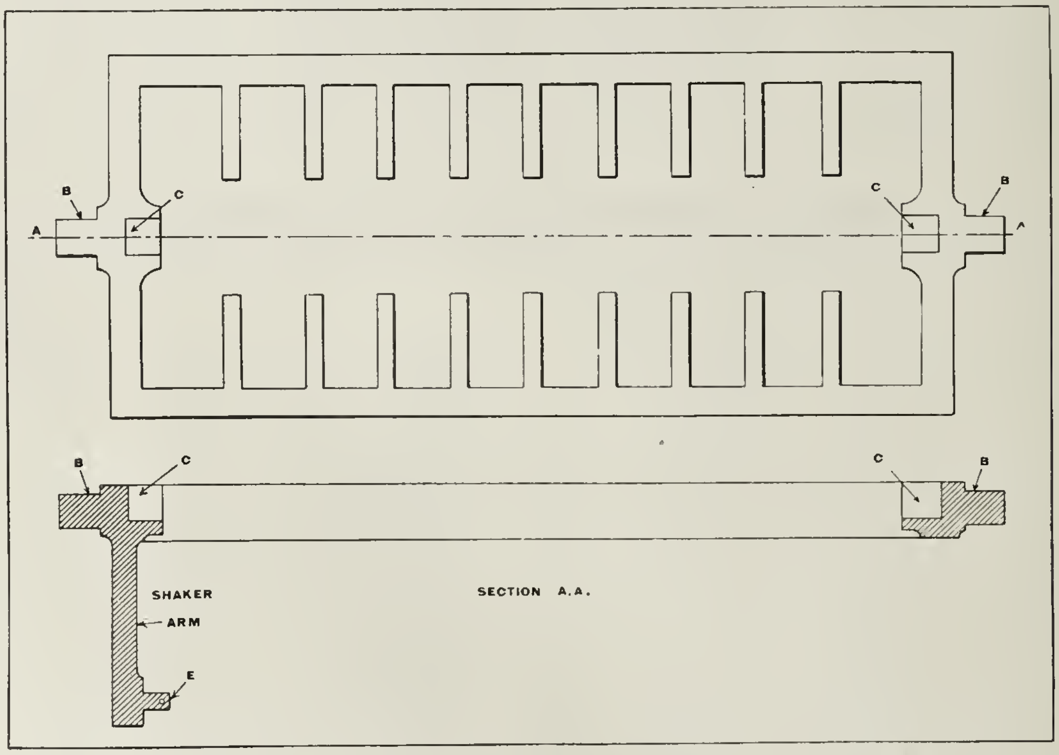


FIG. 1—PLAN VIEW AND LONGITUDINAL SECTION OF A LOCOMOTIVE GRATE FRAME

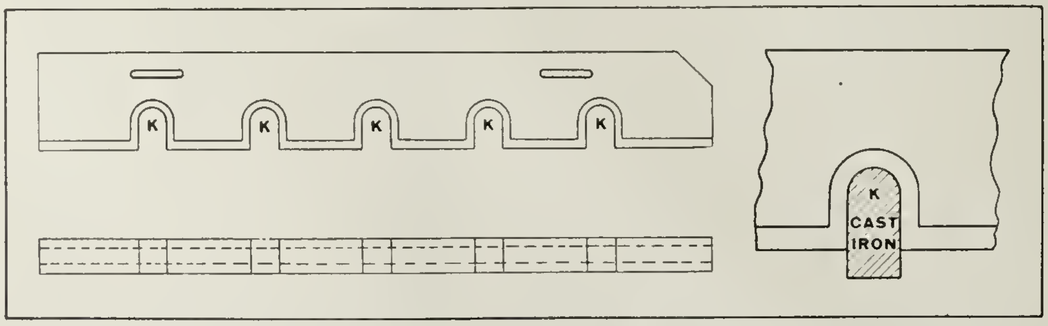


FIG. 2—PLAN AND SECTIONAL VIEW OF A LOCOMOTIVE SIDE BAR ON WHICH CAST IRON CORES WERE USED FOR FORMING THE BEARING SURFACES

cannot be readily secured at the bottom. A cast iron core at this point will effect great economies in the manufacture of these castings. Sectional views of the iron mold which forms this lug are illustrated in Fig. 3. The mold is held together by pins and at *G* is shown a small dry sand core which forms the hole for the key for adjusting the shaking bar to the lug. This cast iron mold was made at a small cost and the joints were not machined as the iron mold is held in position by the sand.

Fig. 4 is a cross-section of a portion of the mold for this grate bar and shows the cast iron mold for the journal and the iron core for the bearing. The various parts of the mold are located by prints on the pattern, the same as when sand cores are used. Fig. 2 illustrates plan and sectional views of a locomotive side bar casting. The openings, *K*, are bearings upon which the journal of the grate frame rests. These bars are usually formed by dry sand cores, but better results are obtained with cast iron cores. These cores insure smooth bearing surfaces and effect economies in core-making.

Does Copper Affect Shrinkage of Steel Castings?

By G. E. Jones

Question:—Why does one brand of pig iron give satisfactory results in a side-blow converter and another brand of the same composition, excepting copper, give metal that shrinks excessively before cooling? In our experience the metal that does not contain copper drains the sinkheads. The composition of the two kinds of iron is as follows: Non-shrinking copper-bearing pig, carbon, 3.74 per cent; silicon, 3.02 per cent; sulphur, 0.016 per cent; phosphorus, 0.03 per cent; manganese, 0.13 per cent; titanium, 0.15 per cent, and copper, 0.60 per cent. Copper-free pig, carbon, 3.46 per cent; silicon, 2.91 per cent; sulphur, 0.012 per cent; phosphorus, 0.042 per cent; manganese, 0.11 per cent, and titanium, 0.41 per cent.

We are using a recarburizer of the following composition: 11 per cent ferro-silicon, 70 pounds; 80 per cent ferro-manganese, 40 pounds; cupola iron, 30 pounds; aluminum, 1 pound; and 25 per cent ferro-titanium, 8 pounds. Can this recarburizer be improved upon in making castings containing about 0.21 per cent carbon? The heats are made in a 2-ton, side-blow converter. The ferro-silicon and ferro-manganese are heated to redness in a ladle, the cupola iron is added and after about one-third of the steel is in the ladle, the aluminum and titanium are thrown in.

Answer:—The presence of copper in steel-making pig iron will tend to reduce the shrinkage, especially when it is present in large quantities. This is due to the fact that copper shrinks less than steel and in combination imparts its characteristic to the alloy. On the other hand, 0.60 per cent copper is not sufficient to make any appreciable difference in the shrinkage. Tests on heats ranging in copper from nothing to 1 per cent have indicated that there is not sufficient decrease in the shrinkage due to this amount of copper to warrant consideration.

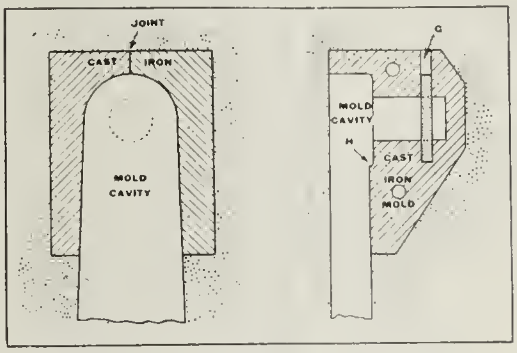


FIG. 3—CAST IRON MOLD FOR FORMING THE LUG OF THE LOCOMOTIVE GRATE FRAME

With reference to recarburizing, there are many ways of making additions. The most accurate method is to add all of the recarburizers in molten form. Such a procedure, however, is too expensive where only a small tonnage is required, and in such cases the ferro-silicon and ferro-manganese may be added cold in the vessel. It is not advisable to add them in the ladle, as the preliminary reaction of ferro-silicon and ferro-manganese should be complete before the other deoxidizers are added. The addition of aluminum and titanium in the ladle is good practice. The writer, however, would suggest a reduction in the amount of aluminum and an increase in the proportion of titanium for the reason that aluminum may leave traces of alumina in the steel. The amount of manganese you mention is correct, but 70 pounds of 11 per cent ferro-silicon would not give the correct percentage in the casting for good practice. You would have to add about 130 pounds. As the addition of large amounts of practically cold material has a decidedly chilling action, it would be better policy to use 50 per cent ferro-silicon. It is necessary to have approximately 0.30 per cent silicon in the casting to insure soundness. This will require about 30 pounds of 50 per cent ferro-silicon, taking oxidation into consideration. The amount of iron you add is very small and will not give 0.21 per cent carbon if your blowing method is correct. It is always advisable to blow flat, which will give you, before recarburizers are added, approximately 0.10 per cent carbon and 0.04 per cent manganese and silicon respectively. It is impossible to recommend the correct amounts of iron and alloys, as they are determined entirely by the method of blowing. If you cut the flame high as the amount of iron added seems to indicate, it is doubtful if you have sufficient silicon, manganese, aluminum or titanium to thoroughly deoxidize the bath and still leave the necessary amount of silicon and manganese in the metal.

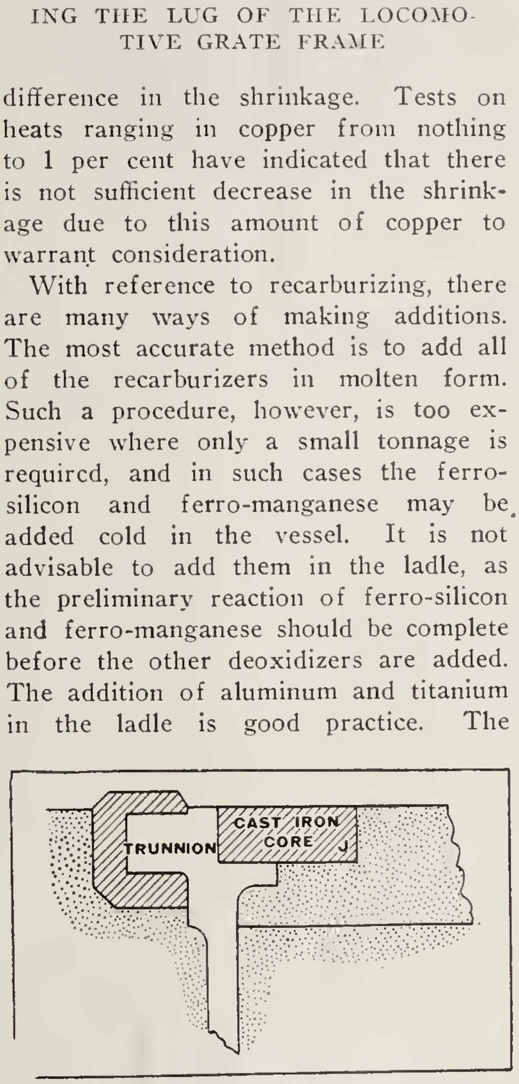


FIG. 4—GRATE BAR MOLD, SHOWING CHILLS IN POSITION

Strong Castings

By W. J. Keep

Question:—We have been asked to figure on cast iron work consisting of an approximately cylindrical piece about 3 inches long and 2 inches in diameter, on which considerable machining must be done, including the cutting of some fine threads. The metal must withstand a tensile test of 13 long tons, or 29,120 pounds, and a crushing test of 45 long tons, or 100,800 pounds. What will constitute the best mixture of iron to accomplish the desired result, bearing in mind that the metal not only must conform to the required tests, but must machine freely?

Answer:—This is a question of mixture, not methods. Such a metal should be made in an air furnace. If you wish to make it in a cupola, you must add steel until you get what you want. Use a mixture of your stock irons that has proved strong and charge with such a mixture from 10 to 20 per cent of steel scrap. Place a small piece of pure aluminum in the ladle to make the castings sound. If you do not wish to use steel, you can use close-grained, low-silicon irons, say No. 3 foundry, and then soften by placing in the ladle enough 50 per cent ferro-silicon to bring the silicon to about 2.00 or 2.5 per cent. The ferro-silicon is placed in the ladle and the iron poured onto it. This will make a close-grained, strong iron soft enough to machine well. It will be necessary for you to find by experiment which method will be most satisfactory.

The C. F. Sammond Co., Milwaukee, agent for the Hill & Griffith Co., Cincinnati, manufacturer of foundry supplies and equipment, has changed its name to the Foundrymen's Supply Co.

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Contents

Page
The American Foundry in a Time of War 127
Castings With a White Core 130
Molding Shells and Grenades for the French Army 131
Determining Proper Weight of the Coke Bed 132
New Converter Plant for Economical Operation 133
Protective Coatings: Japans and Enamels—II 138
Melting Malleable Iron in Electric Furnace 140
The Manufacture of Manganese Steel Castings 141
A Quick Method of Making a Gear Cover Casting 146
The Fundamental Principles of Plate Mounting 147
The Influence of Occluded Cases in Cast Metal 149
Barlow Foundry Reorganized 153
Safety Awards Announced 153
The Inspection of Bronze and Brass Castings 154
The Hardness of Copper Zinc Alloys 155
Problems of the Brass Founder 156
Wax-Finishing Bronze 156
Refining the Grain of Brass 156
Melting With Coal Screenings 156
Tensile Strength of 88-10-2 Mixture 156
Oxides in Ingot Metal 157
Cheap Mixture for Locks 157
Color of Brass Castings 157
Flux for Small Brass Particles 157
Aluminum-Bronze Castings 157
Tobin Bronze Mixture 157
Anti-Friction Metal 157
How Walker Process Reduces Ingot Mold Costs 158
The Pattern Maker of the Hour 162
Recommends Standard Screen Scale for Sieves 163
The Use of Cast Iron Molds and Cores 164
Does Copper Affect Shrinkage of Steel Castings? 165
Strong Castings 165
Contents 166
A Call to Duty 166
Trade Outlook 166
New Equipment for the Foundry and Pattern Shop 167
What the Foundries are Doing 169
New Trade Publications 170

A Call to Duty

UNDER the auspices of the American Foundrymen's Association, the casting manufacturers of the United States will assemble again in annual convention in Boston during the week of Sept. 24. In view of the events that appear to be leading inevitably to war with Germany, it is appropriate that this year's meeting be held amid the historic environment of Bunker Hill. For in this modern war of science, machines and organization, the producers of castings are called upon to play no insignificant part. American foundrymen are, therefore, facing grave and momentous responsibilities.

Will they rise to the occasion?

We think they will, but not without great effort. In the leading article in this issue, Mr. Custer clearly points out the difficulties encountered in producing shells, grenades and other castings for military purposes. You should read every line of this timely contribution, as well as the one following on the manufacture of French grenades. You will then understand why ordinary rough-and-ready shop practice will not do at all for war work, and you will appreciate that the success of American foundrymen in doing their bit for their country in this critical hour depends on the extent of their technical knowledge.

One of the great agencies for the dissemination of this technical information—that may prove vital in the days to come—is the American Foundrymen's Association. Hence, it is essential that the program this year contain a maximum amount of technical information, for the benefit of the many foundrymen who soon may be struggling with an extraordinary problem. The 1917 meeting should perform a distinct service to the country.

To accomplish this end, foundrymen everywhere must co-operate unsparingly and give unstintingly of their time and knowledge for the preparation of papers and for the execution of the work of the technical committees of their association. The call to duty has sounded.

Trade Outlook

A STRONG demand for castings, maintained by domestic industrial activity and stimulated by the eleventh-hour preparedness movement keeps foundries operating at full capacity. Heavy purchases of foundry iron for prompt, second half and 1918 delivery at prices having an upward tendency are important factors of the present market situation. No. 2 foundry iron is quoted at $37 to $38, valley; $37, Chicago; $37 to $38, Cleveland; $39 to $40, Buffalo; $39 to $40, Philadelphia; and $30, Birmingham. Malleable is held at $37 to $38, valley; $37, Chicago; and $39 to $40, Buffalo. Low phosphorus sells at $60 to $61, Pittsburgh, and $65, Philadelphia. Prompt coke is quoted at $10, Connellsville.

New Equipment for the Foundry and Pattern Shop

Small Squeezer-Type Molding Machine of Simple Design—Split-Hand Motion Study Watch—New Safety Sand Blast Machine—Foundry Air Compressor

THE demand for a small and simple molding machine has influenced many manufacturers of foundry equipment to develop various types of pneumatically operated machines. An air squeezer of extremely simple design has been developed by the Federal Malleable Co., West Allis, Wis. As shown in the accompanying illustrations, the working parts of the machine are mounted on a vertical standard railroad rail of heavy section. This material was selected after trials had been made with light I-beams and heavy pipe. It will be noticed from Fig. 2 that the upper head is pivoted to a bracket bolted to the rail. This head swings on a tapered bolt and is so balanced that but little effort is required to swing it. The lower table and cylinder rests on a heavy casting securely bolted to the rail. The bench plate is 21 inches long and 14 inches wide, while the squeezer head is 14 inches long by 8 inches wide. This provides for a wide range in the size of flasks accommodated. The cylinder and piston are said to be constructed in such a manner that it is practically impossible for sand to interfere with the movement of the piston. The action of the piston is controlled by a separate valve made of gray iron and designed for unusually sensitive regulation. A set screw in the valve provides a means of introducing oil for lubrication and a spring holds the seat of the valve in place rendering it air tight. The construction of this valve is said to prevent the possibility of sand entering the working parts.

The machine can be operated at from 60 to 80 pounds air pressure and exerts a squeezing pressure of approximately 4,000 pounds.

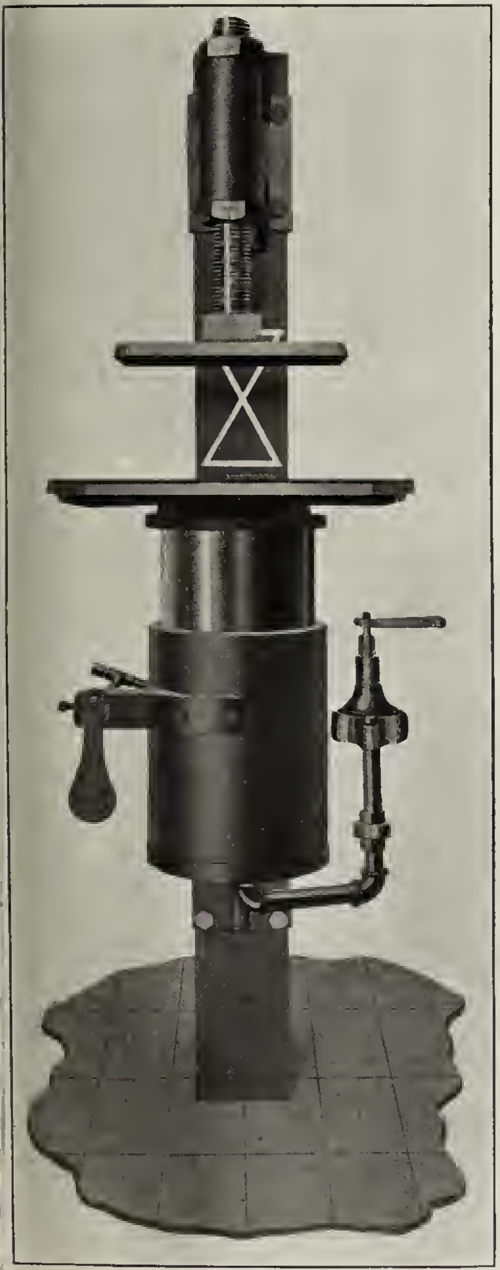


FIG. 1 — FRONT VIEW OF MOLDING MACHINE MADE BY FEDERAL MALLEABLE CO.

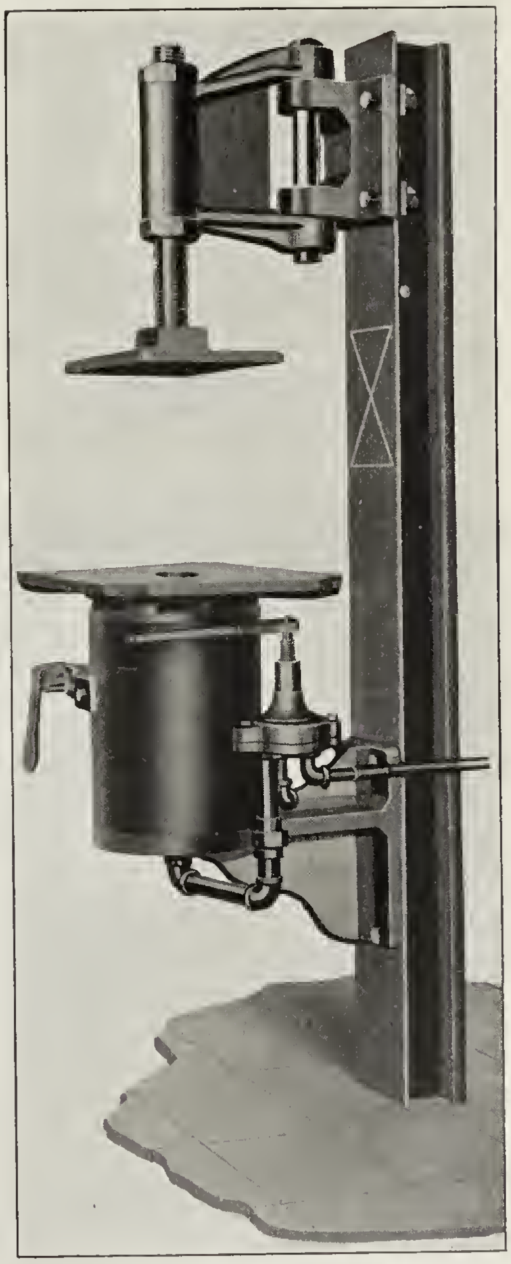
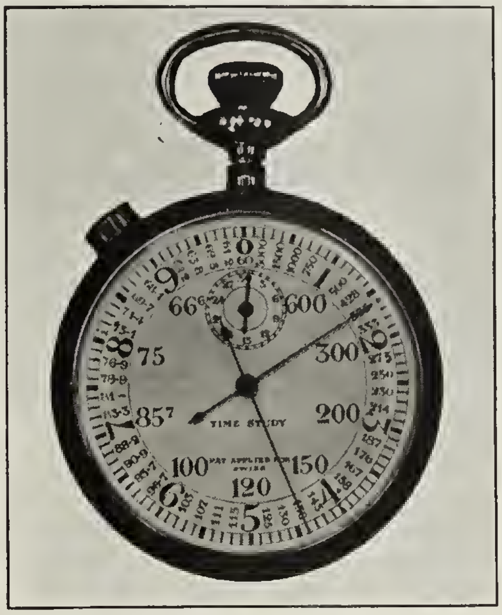


FIG. 2 — SIDE VIEW OF MOLDING MACHINE SHOWING SWINGING HEAD

Motion Study Watch

A decimal computed dial is a feature of the new motion study watch shown in the accompanying illustration. The dial of this split-hand watch is divided into tenths and hundredths of a minute and has legible figures spaced at intervals representing two-hundredths of a minute. A glance at the dial immediately indicates the hourly production or quantity. The combination of this dial with a split-hand watch makes it possible in one observation to obtain both the productive and non-productive time of an operation. The two hands may both be controlled from the crown, or if they are to be used separately, one may be controlled from a side plug. For instance, the crown-controlled hand may be used to determine the gross time and the side-controlled hand may be used to take out the non-productive time or the delays. With one reading, therefore, both the net and the gross time is obtained. This instrument has been developed by Mortimer J. Silberberg, 122 South Michigan av-



MOTION STUDY WATCH

enue, Chicago. The motion study watch embodying the decimal computed dial is a development of the time study instrument which was described in the April, 1916, issue of *The Foundry*.

A New Departure in the Design of Sand Blast Apparatus

The American Foundry Equipment Co., New York, has recently developed a new type of sand-blast room in which the sand-blast nozzle is operated by a workman stationed outside the room and protected from the blast and dust by a fine-mesh screen. This new machine, which is shown in the accompanying illustrations, is a development of a machine brought out by the company some years ago. The original rotary-table apparatus required the presence of the operator within the room to direct the blast. The new type consists of the standard 5, 6 and 7-foot tables in which the regular room is replaced by a semicircular casing with the top slanted off and covered with fine-mesh screen through which the operator sees his work. An opening for the blast is provided by a horizontal slit in a soft-rubber curtain about 3 feet from the floor. The room is illuminated by two special sand-blast lamps. No bucket elevators or air elevating devices are employed.

The original rotary-table room required the presence of a man on the inside to direct the blast and to turn over the work and, where only one room was operated, it was not profitable to have a man on the outside to turn the work and to load unless there was other work for him to do while the blast was in operation. The new type is said to be suitable for any number of installations since the operator may, at any time, shut off the control valve, turn the table and load or unload. If the work is complicated he may turn it as many times as is necessary. Such operation is practical because the operator is entirely removed from the sand-blast area and does not have to wear helmet, coat or respirator, and therefore is not encumbered any more by special clothing than he would be if he were loading castings.

This type of room is designed particularly for use where the castings are not intricately cored and do not require more than one or two turnings to expose all sides to the blast. When cleaning castings which have a deeply recessed core, the operator is afforded protection from the black dust of the cores which would tend to blow directly into his face were he not protected from the blast.

McLain's System, Milwaukee, announces that it has sold a three-ton open hearth steel furnace to the George H. Smith Steel Casting Co., Milwaukee. The work of constructing the furnace has already commenced and it is expected it will be in shape to melt steel April 15.

"The Crucible Problem Solved" is the title of the 12-page folder issued by the Monarch Engineering & Mfg. Co., Baltimore. It illustrates and describes an extensive line of furnaces for melting brass, copper, bronze, aluminum, nickel, ferro-alloys, iron, semisteel, etc., without the use of crucibles. These furnaces are what are known as the open-flame type and in addition reverberatory scrap melting furnaces, tilting furnaces, ladle heaters and core ovens are shown.

Air Compressor for Foundry Use

The accompanying illustration shows an air compressor built by the Sullivan Machinery Co., Chicago, and recently installed by the American Bronze Co. in its plant at Berwyn, Pa. This compressor is a tandem, two-stage, belt-driven machine, with air cylinders 12 and 7.5 inches in diameter, with 10-inch stroke. The machine is operated by a 50-horsepower alternating-current two-phase motor, supplied by Fairbanks, Morse & Co. The compressor furnishes compressed air at 90 pounds pressure and, at its rated speed of 235 revolutions per minute, has a displacement of 306 cubic feet of free air per minute.

The compressor operates at constant speed, and, although the load varies widely, it is stated that the air pressure is maintained constant at 90 pounds per square inch by means of an improved unloader. An interesting feature of this unloader is an arrangement for catching any oil or foreign matter in the air line which would otherwise clog the pilot valve.

As shown by the illustration, the machine is of the enclosed frame

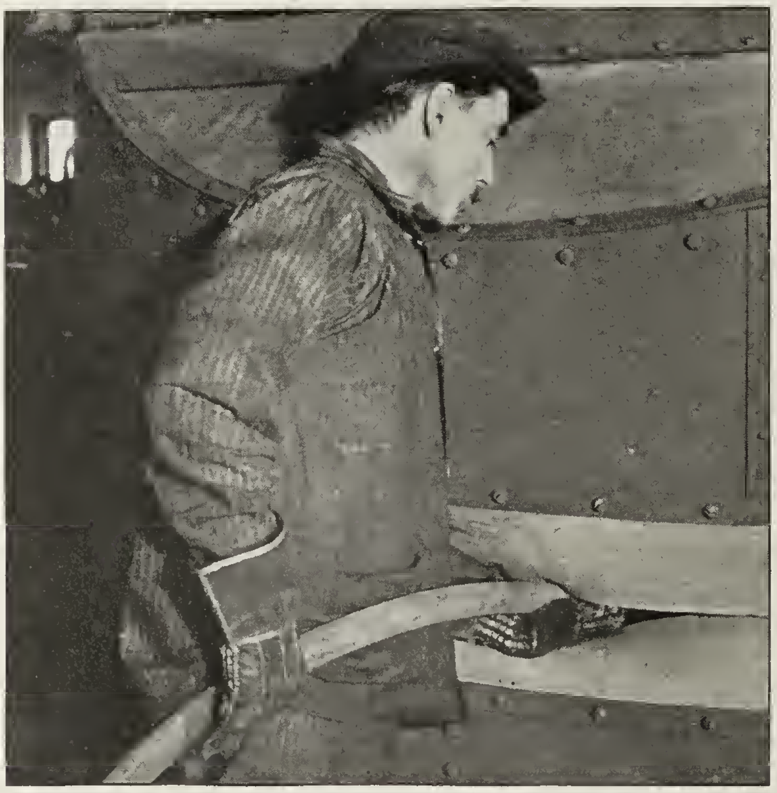


FIG. 1—THE OPERATOR GUIDES THE NOZZLE FROM THE OUTSIDE AND WATCHES THE WORK THROUGH THE SCREEN

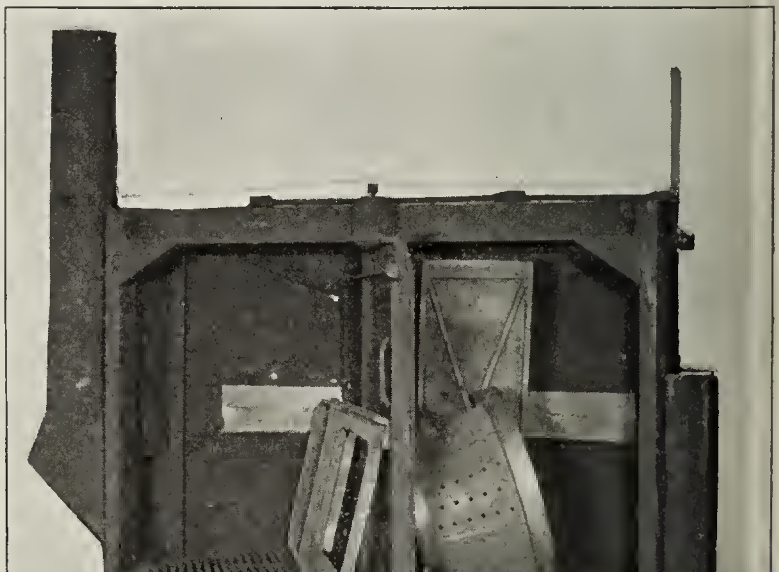
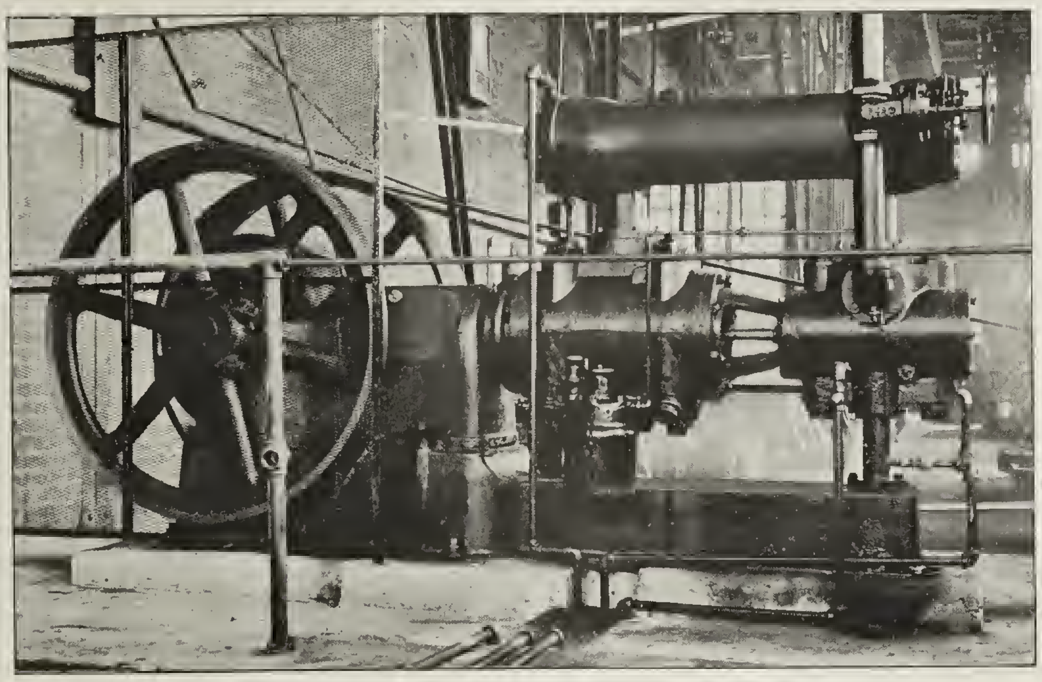


FIG. 2—THE HOSE OPENINGS ARE APPROXIMATELY THREE FEET FROM THE FLOOR OF THE REVOLVING TABLE



AN AIR COMPRESSOR DESIGNED FOR FOUNDRY USE

type, with dust-tight removable covers over the main bearings and at each side of the cross-head guides. The main working parts of the machine are oiled by a splash system while the air cylinders are equipped with sight feed lubricators. An intercooler of an aluminum tube pattern is employed, the air being forced across the cooling tubes three times by means of baffle plates in its passage from the low pressure to the discharge cylinder. Both cylinders are equipped with inlet and discharge valves of the automatic poppet pattern, fitted with special double-cushioned springs which are quiet in operation.

Novo Engine Co. Shares Profits

The Novo Engine Co., Lansing, Mich., has declared its second annual wage dividend. All employes who have been continuously in the service of this company for a period of 12 months prior to Dec. 1, 1916 will receive an amount equal to 5 per cent of their total wages earned during the year and to those who have been in the employ of the company continuously for a period of six months, but less than 12 months, an amount equal to 2½ per cent of their wages will be paid.

The Chicago Foundrymen's Club has issued a calendar of the year 1917 in which the dates of the regular monthly meetings throughout the year are cleverly indicated. The calendar also is arranged so that it is possible to find the day of the week on which any date falls. The calendar is printed in two colors on heavy board and is provided with a ferrule so that it may easily be hung on the foundry wall.

Simon D. Lauffer, 83 years old, died at his home near Irwin, Pa., recently. At one time he was interested in the foundry owned by Lauffer, Hurst & Co., and later he was connected with the Hockensmith Wheel & Mine Car Co. At the time of his death, he was vice president of the Greensburg Foundry & Machine Co.

According to figures compiled by the American Iron and Steel Institute, the pig iron production in the United States in 1916 totaled 39,434,797 tons, as compared with 29,916,213 tons the previous year and 23,332,244 tons in 1914. This production sets a new high mark. Pennsylvania, of course, leads with an output of 16,506,284 tons, which is 41.86 per cent of the total produced, and Ohio ranks second with 8,602,895 tons, which is 21.81 per ment of the total. The production of charcoal iron likewise showed a big increase over 1915 with an output of 372,411 tons, against 2,96.152 tons the previous year. Cold blast charcoal iron, however, showed only a slight increase over the previous year and a tremendous falling off over 1914. Last year the total produced by this process was 5,323 tons, as compared with 5,302 tons the previous year and 9,294 tons in 1914.

Philadelphia Foundrymen Meet

A meeting of the Philadelphia Foundrymen's Association was held Wednesday evening, March 7, at the Manufacturers' Club. The officers of the engineering and construction and repair departments of the United States navy were guests at the meeting. The papers presented discussed navy yard subjects and are as follows: "The Buildings, Lighting and Ventilating", by Mr. Buckwalter; "Cranes in the Navy", by Mr. Austin, and "Foundry Equipment", by Mr. Kremer.

Edward Salts, formerly with the foundry of the Jeffrey Mfg. Co., now is plant superintendent of the Lewis Foundry & Machine Co., Groveton. Pa.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

S. E. Parker, 1800 North Francisco avenue, Chicago, will build a foundry.

The R. E. Parsons Foundry Co., Bridgeport, Conn., will erect an addition to its plant.

The Pennybacker Co., Emaus, Pa., will erect a one-story, 94 x 551-foot addition to its foundry.

The Plymouth Foundry & Machine Co., Plymouth, Wis., will erect a foundry at a cost of $25,000.

The Rath Metal Products Co., 1335 Liberty avenue, Pittsburgh, has changed its name to the Gloekler Foundry Co.

The Jacob & Kugler Foundry Co., Easthampton, Mass., will build a brick, 60 x 60-foot foundry on East street.

The A. & M. Casting Co., 10611 Quincy avenue, Cleveland, will build a steel and brick foundry, 62 x 202 feet.

Two additions, which will cost approximately $18,000, will be made to the plant of the Akron Foundry Co., Akron, O. This company makes gray iron castings.

Plans have been completed by the Saginaw Malleable Iron Co., Saginaw, Mich., for a plant, 136 x 400 feet, to cost $200,000.

La Fonderie d'Acier des Trois Rivieres, Trois Rivieres, Que., Can., will build an addition to its foundry at a cost of $100,000.

The Pier Machine Works, New York City, has been incorporated to engage in the manufacture of metallic castings, pumps and winches, with a capital stock of $50,000. The incorporators are E. Praxmarer, A. Foshay, A. G. Thaanum, 92 Haven avenue.

Davidson & Weiss, architects, 53 West Jackson boulevard, Chicago, will receive bids until May 10 on a foundry to cost $50,000.

The Pressed Steel Automobile Lug Co., Crookston, Minn., contemplates the erection of a new plant, which will include a foundry.

The Ross-Meehan Foundry Co., Chattanooga, Tenn., will erect an annealing shop, 140 x 200 feet, of steel and brick construction.

Contract has been awarded by the Essex Smelting & Refining Works, Irvington, N. J., for the erection of a brass foundry, 22 x 152 feet.

The J. W. Sanders Foundry & Machine Co. will build a $25,000 foundry at DeRidder, La. J. W. Sanders, Shreveport, La., is president.

The Osborne Casting Co., Racine, Wis., has been incorporated with a capital stock of $10,000 by John H. Osborne and Charles Holmes.

The Maytag Co., Newton, Ia., manufacturer of agricultural implements, will build a 1-story, 90 x 100-foot foundry at a cost of $25,000.

A foundry and machine shop will be added to the Litchfield, Ill., plant of the American Radiator Co., 816 South Michigan avenue, Chicago.

The Bay View Foundry Co., Sandusky, O., which has tripled its capacity during the past 18 months, contemplates doubling its present capacity.

The Marshall Foundry Co., Pittsburgh, contemplates erecting an addition to its plant at Black Lick, Pa. The estimated cost is $100,000.

Plans have been prepared for a 125 x 700-foot structural-steel foundry building to be erected by the Ohio Steel Foundry Co., Lima, O.

Contract has been let for the erection of a one-story, 27 x 102-foot foundry for the Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.

The Atlas Foundry & Machinery Co., Tacoma, Wash., contemplates the erection of a foundry and pattern shop, 44 x 225 feet, at a cost of $50,000.

The Ireland & Mathews Mfg. Co., Detroit, will build a plant which, with the equipment, will cost approximately $500,000. A large brass foundry is included.

The Garrett Foundry Co., Brooklyn, N. Y., has been incorporated with $50,000 capital stock by C. H. Fowler, A. W. Trotter and J. C. Garrett, 43 McDonough street.

The Clarksville Foundry & Machine Co., Clarksville, Tenn., has been incorporated with a capital stock of $10,000 by T. B. Foust, S. J. Lowe, H. N. Leach and others.

M. L. Oberderfer, 804 East Water street, Syracuse, N. Y., has awarded the contract for a one-story and basement, 50 x 101-foot core shop addition to his brass foundry.

The Swandler Brass Mfg. Co., Cleveland, has been incorporated with a capital stock of $40,000 and contemplates erecting a plant for the manufacture of plumbers' brass goods.

The Victor E. Knecht Foundry Co., Harrison, O., has been incorporated with a capital stock of $6,000. The foundry of the Campbell Bros. Mfg. Co. has been acquired.

The Superior Steel Casting Co., Benton Harbor, Mich., will erect an addition to its foundry, 140 x 142 feet, which will be equipped with a 10-ton crane and an electric furnace.

Plans have been completed by the American Brass Co. for a 98 x 320-foot foundry of brick and steel construction to be erected at Ansonia, Conn. The estimated cost is $150,000.

The National Malleable Castings Co., Cleveland, is building a foundry at Woodhill road and Woodland and Quincy avenues, which will be 625 x 725 feet. The estimated cost is $500,000.

The Link Belt Co., Indianapolis, Ind., will build an addition to its foundry at a cost of $30,000. The building will be T-shaped, the smaller portion 106 x 140 feet and the larger 106 x 250 feet.

The Kawalle Bros. Co., Manitowoc, Wis., has been reorganized with $20,000 capital and will now be known as the Manumotors Co. The erection of a foundry and machine shop is contemplated.

The stove foundry of the old Smith & Anthony Co. at Wakefield, Mass., was purchased by the Gibby Foundry Co., East Boston, and will be reopened for the manufacture of light machine castings.

The Wadsworth Foundry Co., Wadsworth, O., has been incorporated with a capital stock of $15,000 by William F. Ries, William A. Helmick, C. C. Patterson, Thomas J. O'Brien and Joseph Burgess.

The Harris-Hanson Foundry Co., Stamford, Conn., which has been in business in that city for about a year, has just been incorporated with $25,000 capital stock. Benjamin Harris is president of the company.

The Regent Brass Foundry Co., Marysville, O., has been incorporated with a capital stock of $30,000. The incorporators are Joseph J. Klein, Alfred V. Birnbaum, A. J. Hale, S. M. Davis and E. Weinberger.

The McWane-Tennessee Cast Iron Pipe Co., Rockwood, Tenn., has been incorporated with $100,000 capital stock by F. W. Climer, of Rockwood; J. M. Baker, of Harriman, Tenn., and John R. McWane, Birmingham, Ala.

The Walker Foundry & Machine Co., Pittsburgh, has been incorporated with a capital stock of $100,000 to engage in the manufacture of machinery. The incorporators are W. J. Walker, A. P. Manning and A. F. Hickey.

The Ramey Mfg. Co., Columbus, O., has been incorporated to conduct a foundry business with a capital stock of $50,000. E. J. Ramey, L. S. McKnight, McGee Sweptson, J. A. Sibley and R. E. Pfeffer are the incorporators.

The Warren Electric Steel Co., Warren, Pa., has been organized to engage in the manufacture of electric steel castings. R. T. Harris, general manager, now is receiving bids for the erection of the plant and the necessary equipment.

The De Witt Mfg. Co., Russellville, Ark., has been incorporated to engage in the manufacture of carburetors, with $25,000 capital stock, by D. M. DeWitt, J. F. Hogins and W. F. Bonds. A foundry and machine shop will be operated.

The Irondale Foundry & Machine Co., Birmingham, Ala., has been incorporated with a capital stock of $10,000. A plant will be built for the manufacture of sash weights. J. P. Beggs is president and George W. Dyer secretary and treasurer.

The plant of the Whiteley Malleable Casting Co., Muncie, Ind., burned last November, will be replaced by a new plant which will increase the capacity by one-third. The buildings will be of brick, steel and concrete construction and will cost approximately $300,000.

The Bronzo Alumina Corporation, Tonawanda, N. Y., has been incorporated with $16,000 capital stock to engage in the manufactory of aluminum, silicon, bronze and iron castings. The incorporators are F. A. Redner, J. E. Kaufmann and J. A. Willing, 141 Masten street, Buffalo.

Samuel Harris, Galt, Ont., and Max Goldman, Chicago, have completed negotiations with the Windsor, Can., board of trade for the purchase of 1½ acres on which will be built a $10,000 brass foundry. The firm contemplates occupying the old Coldwell Ideal Co. plant for the present.

The Standard Steel Co., recently incorporated with $50,000 capital stock to engage in the manufacture of farm and stable equipment, has taken over the business of the Abbottsford Mfg. Co., Abbottsford, Wis. The new company contemplates the erection of a two-story building, 60 x 20 feet and a foundry, 60 x 60 feet.

The buildings which will be erected by the Axelson Machine Co., Los Angeles, Cal., are of the following size: Foundry, 100 x 155 feet; machine shop, 130 x 375 feet; pattern shop, 25 x 80 feet; pattern storage, 25 x 80 feet; forge shop, 25 x 75 feet; office, 25 x 100 feet and garage, 25 x 100 feet. These dimensions were incorrectly given in the March issue.

Frank E. McIntyre, now general superintendent of the National Steel Foundries, Milwaukee, a part of the National Brake & Electric Co., has organized the Hercules Casting Co. with a capital stock of $400,000. The new company will establish an open-hearth steel foundry with a capacity of 1,200 tons per month in Milwaukee. The main foundry will be 70 x 500 feet, with a 60-foot bay, and the equipment will consist of two open-hearth furnaces of 20 to 25 tons capacity, to be served by electric traveling cranes. The officers of the company follows: F. E. McIntyre, president and general manager; J. J. McGovern, vice president; E. B. Gennrich, secretary and Francis E. McGovern, general counsel.

New Trade Publications

FIRE ALARM AND DETECTOR.—Illustrations and a description of an automatic fire alarm and detector recently put on the market are contained in a circular issued by the New York Brass Foundry Co., 102 Centre street, New York. This apparatus consists of an electric bell in conjunction with an instrument designed on the principle of a thermometer. It may be used in all kinds of buildings, in the holds of vessels and wherever there is risk of fire.

MELTING AND REFINING FURNACES.—The Monarch Engineering & Mfg. Co., Baltimore, has issued a 12-page booklet descriptive of its line of furnaces for melting and refining brass, copper, bronze, aluminum, nickel, ferro-alloys, iron, semi-steel, gold, silver, cyanides, ores, etc. These furnaces are designed to operate with oil or gas as a fuel. The booklet contains numerous illustrations and a complete list of dimensions for each size of furnace. The booklet also contains a description of the tilting reverbatory type of furnace manufactured by this company.

VACUUM PUMPS. — The Ingersoll-Rand Co., New York City, recently issued two catalogs devoted to dry vacuum pumps, covering straight line and duplex types. Both machines which are equipped with Ingersoll-Rogler valves, are capable of maintaining a high vacuum and will handle discharge pressures of several pounds. The maximum degree of vacuum possible varies between the different machines to within 0.6 inches of the barometer. The pumps are offered in steam and power-driven types in a large range of sizes and capacities. Both catalogs are well illustrated in colors and show the machines in whole and in section.

The FOUNDRY
May 1917
CLEVELAND, OHIO.
Vol. 45, No 5, Whole No. 297.

How the Foundry Industry Has Prepared for War

By Promptly Meeting Rapidly Changing Economic Requirements Foundrymen Have Kept Their Houses in Order and Are Prepared

Prosperity in Midst of Many Crises Proves Valuable Experience to Foundrymen

PREPARED for any eventuality! That is the answer of the American foundry industry to Uncle Sam's call for aid in the present crisis. Casting manufacturers have been in training for 2½ years to meet such a contingency as exists at present. They have prepared, consciously or otherwise. They have been compelled to cope with strained situations imposed by labor, readjustments due to advancing raw material markets and demands for product greatly in excess of the capacities of their plants. They have successfully coped with the ever-changing conditions and their houses are in order. Plant extensions have been made unstintingly to meet immediate rather than future needs, labor-saving equipment has been installed and efficiency systems have been adopted that place the foundry trade in the front rank of America's prepared industries.

This state of preparedness, however, has not been achieved without great sacrifice. Labor scarcity and insistent and continuous demands for higher wages developed many crises that had to be met. Increasing costs of raw materials had to be adjusted to low priced contracts. Deferred deliveries of equipment retarded much needed improvements, yet each situation has been faced successfully and every problem has been satisfactorily solved.

The foundry industry will now be weighed in the balance, but will not be found wanting.

But, as Howard E. Coffin so aptly put it, "We need prosperity in war time even more than when we are at peace." Casting manufacturers today are enjoying the greatest era of prosperity in the history of the country. Order books filled to overflowing are the best answer to any query regarding a threatened depression.

"Now is the time to open the throttle," says Mr. Coffin. It is wide open in every casting plant. Full steam is on and every casting shop is operating at full capacity. Advancing raw materials reflect the pressing demand. The government expenditures alone will more than compensate for any evil effects arising from a temporary hysteria following the declaration of war. And the raw material markets are the luminous sentinels that have and will continue to light the way for American casting manufacturers. Therefore, a resume of war conditions involving violent price changes, may foreshadow and safeguard the future.

THAT iron and steel, more than men, are the factors which make possible the conduct of wars is indicated by the meteoric rise of foundry iron prices from July, 1914, to the present time. The average quotations of all foundry grades have practically trebled, scrap prices have nearly doubled and Connellsville coke has advanced 400 to 500 per cent. To the foundryman who has been accustomed to figure upon a fraction of a cent increase in the cost of his iron, these advances in a period of less than three years have compelled him to change entirely the basis of his computations. The accompanying chart graphically shows the movement of all grades of foundry iron since July, 1914, to April, 1917, and in the accompanying table are given the average price variations from month to month. It will be noted that for a period of more than a year, namely from July, 1914, to August, 1915, prices remained almost stationary with the exception of a slight decline during the closing months of 1914, immediately following the declaration of war. The first eight months of last year witnessed no sharp price changes, but it became apparent in the last quarter of the year that in 1917 the production of pig iron would be insufficient to meet the requirements and since October and in a period of only seven months, prices have been practically doubled. During the month of April nearly all grades were marked up and there is every indication that further advances will be made. Low phosphorus pig iron has been sold as high as $75 per ton and $100 per ton is predicted. Lake Superior charcoal iron now is on a $40 basis and

"Open the Throttle," Says Howard E. Coffin

"We need prosperity in war time even more than when we are at peace. Business depressions always are bad but doubly so when we have a fight on our hands. The declaration of war can have no real evil effect on business. What bad effects are apparent are purely psychologic and largely of our own foolish making, for our markets are the same in April that they were in March. We need more business, not less. There is real danger in hysteria. Indiscriminate economy will be ruinous. Now is the time to open the throttle."

numerous sales of No. 2 foundry iron at this price have been reported.

One of the peculiar features of the foundry iron situation is the fact that scrap has not moved upward in line with foundry pig iron prices. Since July, 1914, quotations have doubled, whereas pig iron prices have been increased threefold. For practically a year after war was declared scrap was a drug on the market, although in the closing months of 1915 the demands for this material began to increase and while prices remained fairly steady throughout 1916, the advance since the first of the year has been marked and has been more in line with the increased quotations on pig metal. At the beginning of the war cast scrap was quoted in Chicago at $9.65 per ton, as compared with $19.50 per ton today and at Philadelphia in gross ton lots it was held at $12 in the summer of 1914, against $24.75 for the month of April. Malleable scrap at Chicago sold at an average price of $9 per ton in July, 1914, whereas malleable scrap is held at $20 today.

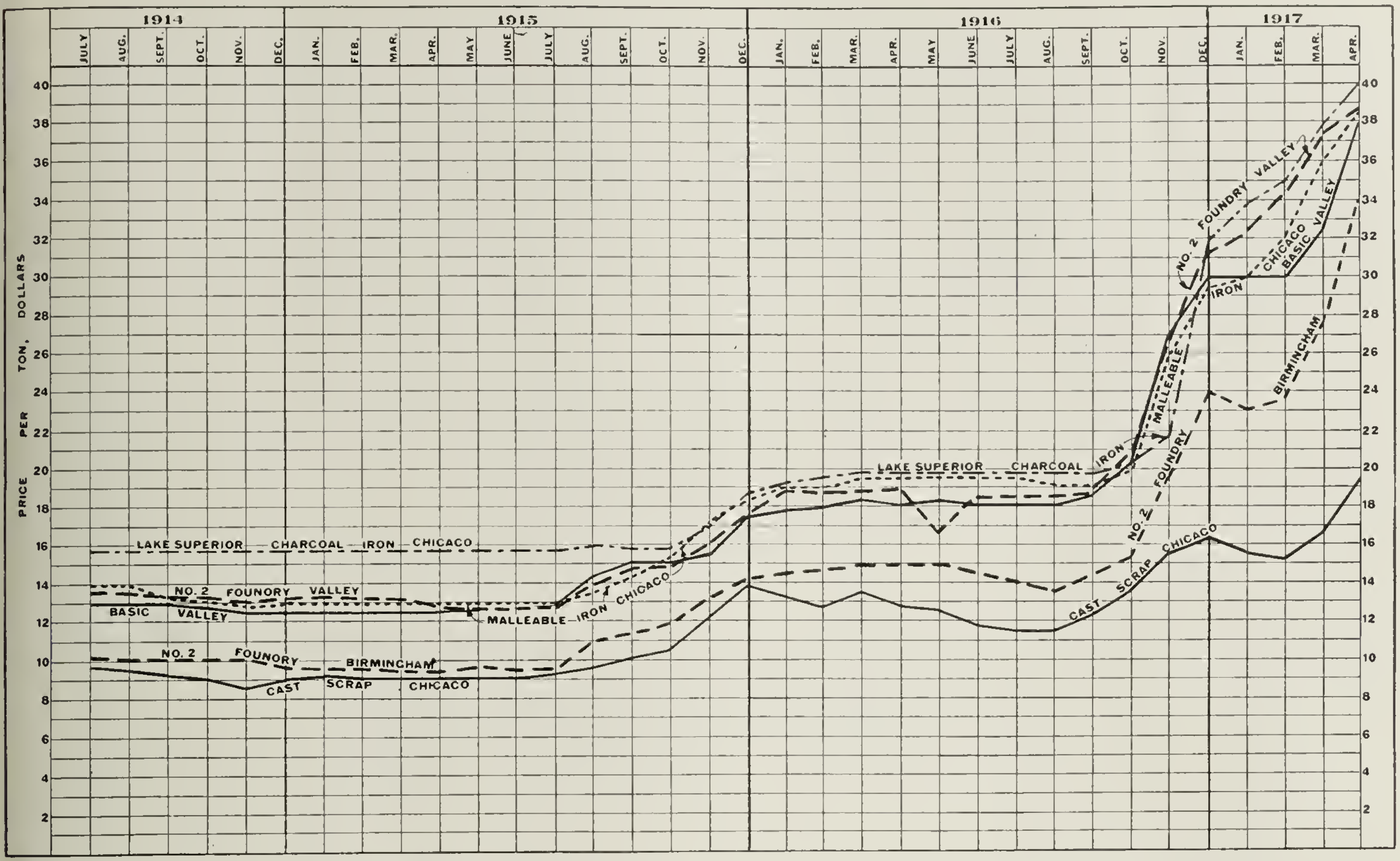
Let Our Washington Office Serve You

Washington today is the center of the nation's activity, both political and industrial. In this mad rush of preparation our Capital city is the mecca toward which all eyes are turned. Foundrymen unaccustomed to dealing with the government, who are figuring on munition and other work, are being called upon to submit their propositions in person. For many years, the Penton Publishing Co., publisher of *The Foundry*, has maintained an office in Washington in charge of L. W. Moffett, one of its associate editors. This office is at the disposal of every foundryman in America as his headquarters while in Washington. Mr. Moffett will extend you every courtesy and will aid you on your mission. Any communications addressed to him will receive immediate attention. The office is located at 708 Metropolitan Bank building, in the heart of the business district. Incidentally, this is the only office in Washington separately maintained by a publisher of trade and technical papers and in charge of an associate editor to whom has been extended the courtesies of the Press Galleries of the senate and the house.

Probably the most spectacular performance during this war period was staged by ferro-manganese, which truly can be said to be a *war bride* in every sense of the word. Steel founders, who are compelled to use this material, and gray iron foundrymen who buy it in small lots, must carefully figure upon this addition, which now involves the investment of a considerable sum. With foreign shipments practically cut off and the demand for this material increased, the unusual rise in its value is not surprising. Just prior to the declaration of war in 1914, the average during the month of July was $37.54, but when an embargo was declared the following month by England, the average price increased to $102.08. A sharp decline followed the temporary lifting of this embargo, although prices steadily advanced thereafter until the closing months of the following year saw an average of more than $100 per ton. In 1916 ferro-manganese staged some wonderful acrobatic feats and in April of last year sales were made at more than $400 per ton. From that high point prices gradually declined until November, when $165 was reached, but since that time there has been a steady advance and small sales were made last month on the basis of nearly

Average Monthly Prices of Foundry Iron, Machinery and Malleable Scrap, Ferro-Manganese and Coke Since the Declaration of the European War

	No. 2 Foundry Iron, Valley, gross ton.	No. 2 Foundry Iron, Chicago, gross ton.	No. 2 Foundry Iron, Birmingham, gross ton.	Malleable Iron, Chicago, gross ton.	Lake Superior Charcoal Iron, Chicago, gross ton.	Low Phosphorus Iron, Philadelphia, gross ton.	Basic Iron, Valley, gross ton.	Ferro-manganese, gross ton.	Connellsville Fdy. Coke at ovens, net ton.	Cast scrap, Chicago, net ton.	Cast scrap, Philadelphia, gross ton.	Malleable scrap, Chicago, net ton.
1914.												
July	$13.50	$14.00	$10.15	$14.00	$15.75	$20.50	$13.00	$37.54	$2.27	$9.65	$12.00	$9.00
August	13.30	14.00	10.00	14.00	15.75	20.75	13.00	102.08	2.21	9.50	12.00	8.88
September	13.25	13.63	10.00	13.25	15.75	21.00	13.00	39.45	2.09	9.19	12.00	8.25
October	13.08	13.30	10.00	13.00	15.75	20.90	12.85	70.08	2.00	9.00	11.40	7.90
November	12.88	13.00	10.00	12.88	15.75	20.12	12.48	67.84	1.92	8.56	11.00	7.75
December	13.07	13.00	9.65	12.90	15.75	20.00	12.50	68.00	1.94	9.00	11.30	7.95
1915.												
January	13.25	13.00	9.50	13.00	15.75	20.00	12.50	68.00	2.00	9.19	12.00	8.13
February	13.25	13.00	9.50	13.00	15.75	20.00	12.50	78.80	2.00	9.00	12.00	8.00
March	13.25	13.00	9.38	13.00	15.75	20.00	12.50	95.00	2.00	9.00	12.00	7.94
April	12.95	13.00	9.35	13.00	15.75	20.00	12.50	95.00	2.00	9.00	11.75	8.00
May	12.75	13.00	9.73	13.00	15.75	20.00	12.65	97.00	2.00	9.00	12.13	8.14
June	12.75	13.00	9.56	13.00	15.75	20.60	12.72	105.11	2.00	9.00	12.25	8.13
July	12.86	13.00	9.60	13.00	15.75	21.37	12.96	103.57	2.00	9.25	12.38	8.90
August	13.94	13.38	11.00	13.44	16.00	22.12	14.36	101.36	2.00	9.62	13.30	10.00
September	14.75	13.80	11.30	14.30	15.85	24.35	15.00	110.00	2.09	10.10	14.00	10.25
October	14.86	14.44	11.75	15.25	15.75	26.25	15.01	109.64	2.35	10.50	14.00	10.25
November	15.92	17.12	13.12	17.13	17.00	29.40	15.52	100.42	2.87	12.13	14.50	11.38
December	17.52	18.00	14.20	18.20	18.65	31.60	17.49	103.04	2.95	13.75	16.06	13.75
1916.												
January	18.92	18.50	14.50	19.00	19.20	32.00	17.83	139.88	3.75	13.31	17.00	13.81
February	18.75	18.50	14.63	19.00	19.50	32.00	17.98	215.13	3.75	12.81	17.00	13.33
March	18.77	18.70	15.00	19.40	19.75	32.00	18.25	334.75	3.60	13.45	17.00	13.95
April	18.88	19.00	15.00	19.50	19.75	33.75	18.00	412.50	3.87	12.88	17.88	13.89
May	16.69	19.00	15.00	19.50	19.75	34.00	18.16	347.73	3.13	12.56	17.50	13.44
June	18.50	19.00	14.45	19.50	19.75	33.50	18.00	244.88	3.00	11.75	16.50	11.73
July	18.50	19.00	14.00	19.50	19.75	33.25	18.00	198.75	3.00	11.50	16.00	11.63
August	18.50	19.00	13.60	19.00	19.75	34.00	18.00	173.18	3.05	11.50	16.00	11.25
September	18.65	18.65	14.38	19.00	19.75	34.25	18.63	167.67	3.25	12.13	16.00	11.50
October	20.75	19.15	15.13	19.88	20.35	38.00	20.31	165.00	4.38	13.50	16.15	12.38
November	26.07	25.00	19.60	25.80	21.95	46.00	27.23	165.00	9.00	15.55	18.50	16.00
December	31.30	30.00	24.00	29.50	31.75	51.00	30.00	170.00	9.25	16.25	20.75	18.00
1917.												
January	32.36	30.00	23.00	30.00	33.75	54.00	30.00	169.00	10.35	15.50	20.75	17.75
February	34.26	32.00	23.50	32.00	34.75	57.00	30.00	250.00	11.00	15.25	20.00	17.25
March	37.21	35.70	27.50	35.80	37.55	63.80	32.54	275.00	11.30	16.70	22.00	17.75
April	38.50	38.50	34.00	38.25	40.00	73.00	38.00	350.00	9.75	19.50	24.75	20.00

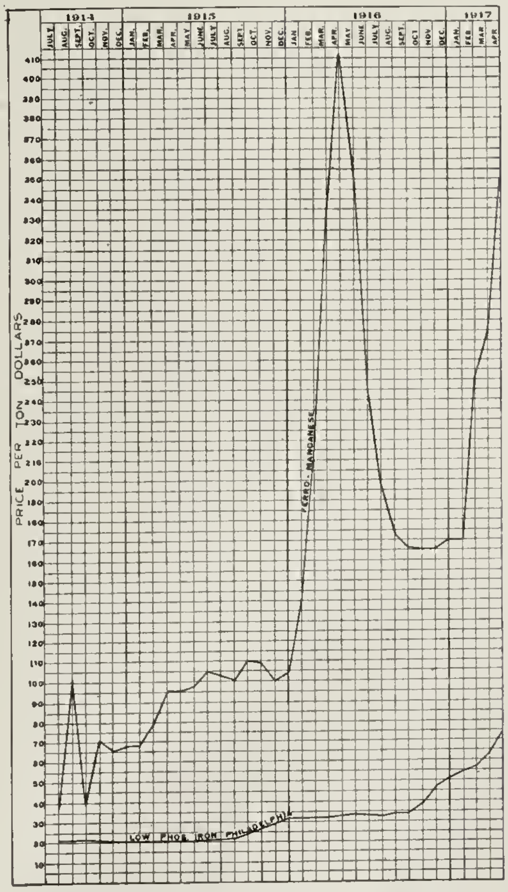


FLUCTUATIONS IN THE PRICES OF FOUNDRY IRON AND CAST SCRAP SINCE THE BEGINNING OF THE WAR IN 1914

$400 per ton. Still higher prices are predicted and some of the bulls who handle this material predict a price of $1,000 per ton before the end of the year.

To add to his other difficulties, the foundryman during the past year has faced an inadequate supply of fuel and the situation became so acute during the winter months that production of castings materially declined. Many factors contribute to the shortage and high price of foundry fuel, namely the tremendous consumption of this material by the blast furnaces, scarcity of labor and the shortage of the coal supply. Connellsville foundry coke, which sold at less than $2 per ton at the ovens at the close of 1914, has advanced to $10 and $11 per ton for spot shipment, and notwithstanding the slightly improved car situation, it is extremely doubtful whether prices will decline materially this year. Numerous expedients have been tried to compensate for the shortage of this fuel by the use of bituminous coal charged into the cupola with the coke and also by the employment of a crude oil residue, which is almost pure carbon and which materially increases the temperature of the iron. The large increase in the output of by-product coke has not contributed toward relieving the general coke situation, since the increment in the production of these plants has been absorbed by the increased blast furnace capacity completed only recently.

Plumbago or graphite is the principal material used in the manufacture of crucibles, and almost all of this material is imported from the island of Ceylon. Immediately upon the declaration of war, England placed an embargo on all shipments of this product, which was not lifted until the following March. During this period practically all of the reserve stock in this country was consumed and when the embargo was lifted, the demand for plumbago was so great that prices were advanced sharply and they have continued moving upward ever since. The stock in Ceylon was quickly exhausted, the supply having been small on account of race riots, labor troubles and a particularly heavy rainy season. Added to this difficulty was the shortage of vessels and until a comparatively recent date, it was almost impossible to secure bottoms.



THE ACROBATICS STAGED BY FERRO-MANGANESE AND THE MARKED UPWARD TREND OF LOW PHOSPHORUS IRON IN WAR TIMES

Prior to August, 1914, crucibles were selling from 3½ to 5 cents per number and plumbago could be purchased from 2½ to 7 cents per pound. Today No. 1 lump Ceylon plumbago is selling at 28 to 30 cents per pound, New York; No. 1 chip, 19 to 22 cents per pound and No. 1 dust, 10½ to 13 cents per pound. Instances have occurred during the past year where even higher prices were asked on account of excess charges in the way of freights, insurance, etc. The scarcity of plumbago was particularly acute in the summer and fall of 1916, due not so much to the scarcity of the material itself, as to the absence of freight space, very few vessels having been in service from the far east at that time. More boats were put on late in the fall, however, and the plumbago tonnage increased rapidly during December, January and February. Recently some trouble has been experienced in obtaining shipments from Ceylon, due to the scarcity of gold and silver, which made it difficult for the banks to negotiate what are known as *rupee* drafts. At one time in February, business in all lines in the far east was almost at a standstill on account of this situation, but this recently was relieved by the British government, which sent large amounts of specie to Ceylon. The situation also was relieved by the negotiation of loans in India, which resulted in placing in circulation the gold and silver currency of that country.

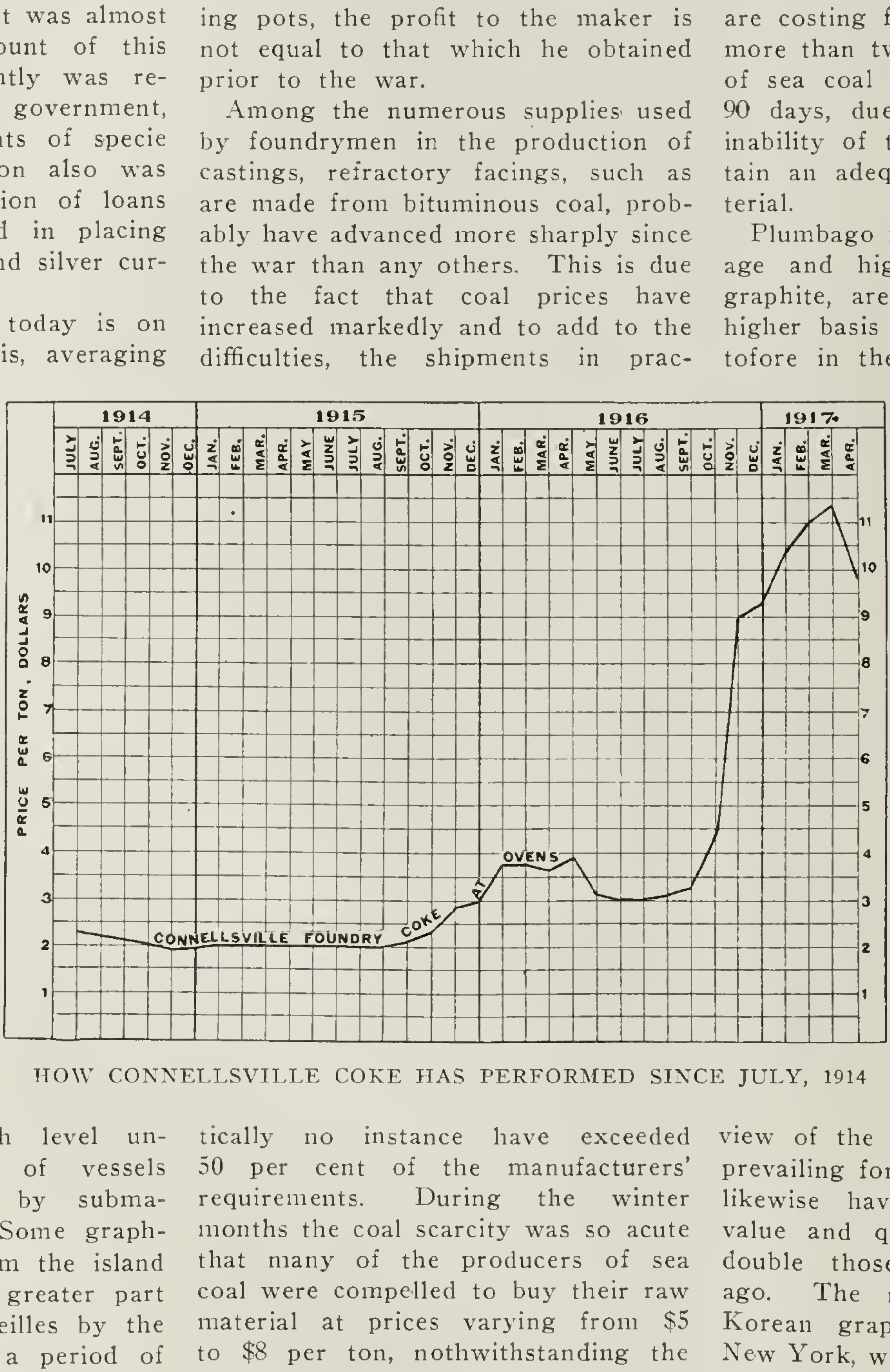
Production in Ceylon today is on a fairly satisfactory basis, averaging normal or slightly better. Marine freights, however, are unusually high. During normal conditions, shipments are made from Colombo, Ceylon, to New York, at 30 shillings per ton, whereas today it varies from 325 to 350 shillings. Present indications point to a continuation of shipments in fair quantity, but as long as the war continues, there is little likelihood of a sharp decline in prices. Even after the war, it is believed that this decline will be gradual, due to the fact that freight rates will be maintained at an exceedingly high level until the large number of vessels that have been sunk by submarines can be replaced. Some graphite has been shipped from the island of Madagascar, but the greater part was embargoed at Marseilles by the French government for a period of almost two years, and only recently it was released.

All manufacturers of crucibles were users of German clay prior to the war, but no satisfactory substitute has been found for it, although experiments have been made with hundreds of different varieties. The demand for clays at all suitable for making brass founders' pots is so great that prices have been advanced sharply, in one instance from less than $10 to $100 per ton. Railroad embargoes, shortage of cars and unsatisfactory weather conditions also have added to the difficulties of securing clays in this country. However, conditions today are considerably improved and stocks of both plumbago and clay in the hands of crucible manufacturers are much larger than at any time since war was declared. Increased cost of labor also has been a factor in adding to the cost of crucible production and notwithstanding the price of 18 cents per number prevailing for brass melting pots, the profit to the maker is not equal to that which he obtained prior to the war.

Among the numerous supplies used by foundrymen in the production of castings, refractory facings, such as are made from bituminous coal, probably have advanced more sharply since the war than any others. This is due to the fact that coal prices have increased markedly and to add to the difficulties, the shipments in practically no instance have exceeded 50 per cent of the manufacturers' requirements. During the winter months the coal scarcity was so acute that many of the producers of sea coal were compelled to buy their raw material at prices varying from $5 to $8 per ton, nothwithstanding the fact that the selling price did not exceed $6 per ton. From a basis of $3 per ton, prevailing in the summer of 1914, sea coal has advanced to $8 and this price barely covers the cost of manufacture. In some instances coal companies that have been furnishing raw material to these plants for many years, notified the producers this spring that they would not renew their contracts even at 100 per cent advance and as a result some of the sea coal makers are compelled to cover their raw material requirements from day to day in the open market. The coal shortage promises to develop a serious situation for foundrymen and in view of the large tonnage sold for export, the available supply for domestic consumption will be much less this year than heretofore. Concurrent with this reduced supply will be further advances in prices which directly will affect the manufacturers of sea coal. The cost of labor in these plants likewise has advanced fully 50 per cent and all supplies are costing from 100 to 200 per cent more than two years ago. Shipments of sea coal are deferred from 60 to 90 days, due almost entirely to the inability of the manufacturers to obtain an adequate supply of raw material.

Plumbago facings, due to the shortage and high prices prevailing for graphite, are being sold today on a higher basis than has prevailed heretofore in the foundry industry. No. 1 Ceylon dust is quoted at from 8 to 10 cents per pound, No. 2 dust from 6 to 8 cents per pound, and flying dust from 7½ cents per pound, delivered New York. While each manufacturer of plumbago facings has many different grades, nevertheless it can be assumed that those that are being sold at low prices naturally will contain a comparatively small percentage of Ceylon plumbago. Both Canadian and Korean graphites are being used extensively in the manufacture of facings, but in view of the scarcity and high prices prevailing for Ceylon plumbago, these likewise have sharply increased in value and quotations are practically double those prevailing two years ago. The normal freight rate on Korean graphite is $8 per ton to New York, whereas recently as high as $25 per ton has been paid. Coke blackings have advanced in line with the sharp increase in coke prices, manufacturers being compelled to pay from $9 to $11 per ton for their raw material. It is exceedingly doubtful if prices will decline in the near future, owing to the fact that the consumption of coke will continue heavy, owing to the tremendous requirements of the pig iron and casting manufacturers.

Molding sand can scarcely be considered to be a *war bride*, yet the cost of mining and shipping has increased fully 50 per cent during the past two years. Coarse sand which sold from



HOW CONNELLSVILLE COKE HAS PERFORMED SINCE JULY, 1914

75 cents to $1 per ton prior to the summer of 1914, is selling today from $1 to $1.25 and various grades of fine sand are quoted at $1 to $1.50 per ton. Labor costs before the war at sand pits in the central states varied from 17½ to 25 cents per hour and teams from 40 to 50 cents per hour. Today labor costs range from 30 to 40 cents per hour, depending upon the locality, and teams cannot be had for less than from 70 cents to $1 per hour. In addition, the cost of supplies, steel castings, repairs, etc., has advanced from 50 to 300 per cent and the cost of explosives has practically doubled. One miner and shipper of molding sand states that the increase in the cost of labor in the eastern section of the country during the past two years has been 57½ per cent. To add to their difficulties, the government will not permit the operation of vessels carrying sand in the Delaware bay at night, which materially increases the cost of shipping.

Among the smaller supplies used in casting plants, the percentage of advance on chaplets probably is greatest. This is due entirely to the tremendous increase in the cost of steel and tin and with plates selling at 6 to 7 cents per pound, further advances are anticipated. Early in 1915, the discount to consumers on all diameters of forged head chaplets was 70 and 10 per cent, as compared with only 33 1/3 per cent today. Two years ago the discount on double-head chaplets with round or square plates fitted, water back, round and square head chaplets and double-head chaplets with forged heads, was 75 and 10 per cent, as compared with only 40 per cent today. The increase in the extras also is large, from 4½ cents per pound for extra size plates to 12½ cents. Other supplies, such as bellows, shovels, swabs, riddles, etc., have been directly affected by the scarcity of materials entering into their manufacture, and prices have been practically doubled. Inability to secure leather, combined with the high price of this material, has compelled manufacturers to mark up quotations on bellows. Makers of riddles experience difficulty, even at the high prices prevailing, in securing wire and rims, while the shortage of swabs continues acute.

History of Nickel Plating for Stove Decorating

The ores containing nickel are of a complex nature and it is difficult to separate the nickel from other ores of cobalt, arsenic, copper, etc. Nickel alloys, such as German silver, were made long before the pure metal could be separated in a commercial way. In 1868, Monnier, of Philadelphia, patented a process for separating nickel, but for several years after that it was not obtainable in sufficient quantities to make possible its introduction in the mechanical arts. Wharton made nickel cooking utensils as early as 1873.

Nickel was not used in Europe before 1875, when extensive deposits of ore were found in New Caledonia and were shipped to France to be smelted. Nickel plating, or the deposition of nickel on iron and the softer metals, was invented by Isaac Adams Jr., of Boston, the patents having been secured from 1869 to 1872. During the winter of 1871-2 a working exhibit of the Adams process was shown at the Mechanics Institute's fair in New York City. At the same fair Fuller, Warren & Co., Troy, N. Y., exhibited Keep's baseburning stove with a fire in it. This was the first stove having a double row of mica lights. This stove was purchased by a New York banker who requested that all of the surfaces be nickel plated and polished to serve as an attraction in his bank. The cost of this work by the Adams process was considerably in excess of $100. We were informed that this was the first application of nickel to stove parts. I left the employ of Fuller, Warren & Co. in 1875, but prior to that time they had received a license to operate this process and had installed a nickel-plating department. In 1876, the Michigan Stove Co., Detroit, installed a nickel-plating plant and both Fuller, Warren & Co. and the Michigan Stove Co. exhibited portable nickel-plated parts at the Centennial exhibition in Philadelphia, in 1876. Prior to 1877 a plating firm in Alabama was making nickel trimmings for quite a number of firms. I was the first one to use a portable, carved nickel band on the front edge of the top of a cooking range. This was in 1877 or 1878. Portable nickel rings were used on the tops of baseburners before that time.

About 1885, the Michigan Stove Co. determined to nickel the edges of range tops and since the carved, portable edges did not meet with the views of the heads of this company, they decided to adopt a plain edge. Shortly thereafter, Ireland & Matthews made steel edges for us which were nickel-plated, but up to that time Matthews & Willard, of Waterbury, Conn., furnished the greater part of nickel trimmings for stoves. The entire upper portion of the Garland baseburner was made out of brass which was nickel plated. The use of elaborate nickel decoration followed the expiration of the Adams patents in 1887. In the west, carved ornamentation and a white unpolished background were the prevailing styles, while in the New England states, plain, polished nickel was preferred. Within the past 10 years plain nickel has come into general use.—*Abstract from manuscript entitled "History of Stoves", by W. J. Keep.*

Leaky Malleable Fittings

By Dr. Richard Moldenke

Question:—We are at present buying malleable fittings 3/16-inch thick and do not get one out of 20 that will stand 110 pounds air pressure without leaking. Cannot air tight castings be made more regularly?

Answer:—The malleable casting is originally a white iron product which is subsequently changed to the material we know by the annealing process. It therefore is subject to the enormous shrinkages in volume incident to that form of cast iron. The result is that the interior of a malleable casting is inclined to be more or less spongy or porous. If the metal is of poor quality, that is, oxidized, dirty, or not of proper composition, this difficulty from unsound interiors is accentuated considerably.

It is quite possible that in the annealing process, with the removal of the carbon from the surface, avenues of escape for air under pressure are opened up right through the casting. If the castings were packed in fire clay instead of iron oxide of some form, this removal of carbon from the outer layers of the metal would be greatly retarded, if not be overcome altogether. This would not hurt the malleable qualities of the metal sufficiently to unfit it for pipe fittings, but it would be a little weaker under shock and strain. The castings would doubtless be sounder under test and should be amply able to stand 110 pounds air pressure.

In actual operations on a large scale, sand would be easier to handle for a packing material than fire clay. Lime should never be used as it affects the surfaces injuriously under long-continued heat. Particular attention should be given the patterns so as to have good, big sprues and gates in order that the castings may have every chance to be as sound as white iron can be made. This, with annealing in sand or fire clay, will give castings exhibiting the carbon change (combined carbon to temper carbon) necessary to make a blackheart casting, but without the surface carbon being removed, thus making for the best grade of work.

Sensible Flask Equipment for Machine Molding

In Many Cases it is Advisable for the Sake of Economy to Alter the Design of the Pattern to Suit the Flask

By Paul R Ramp

INSTANCES frequently arise in foundries operating molding machines where it is more economical to alter the pattern than to make a new set of flasks. As a matter of fact, one of the most expensive items involved in the operation of molding machines is the cost of the flask equipment. It is the customary procedure to make the pattern first and to design the flask to suit the requirements of the pattern. However, there are many instances where it is advisable to reverse the operation and to adapt the pattern to the flask. While it is true that this practice has its limitations, nevertheless occasions frequently arise when this mode of procedure is advisable and frequently the quality of the casting can be improved and the cost of molding reduced.

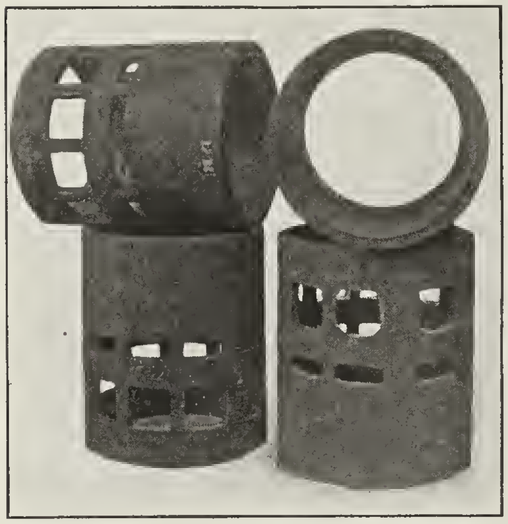


FIG. 1—PISTON VALVE BUSHINGS FOR LOCOMOTIVE CYLINDERS

Since it is possible to reduce the general dimensions of the pattern at the core prints only, the greatest economies only are effected in the depth of the flask and, therefore, this suggested mode of procedure involves the use of shallow flasks for deep molds. An interesting example of this is illustrated by the castings shown in Fig. 1, which are piston valve bushings for locomotive cylinders. When this work was received in the shop, these castings were considered too large to be molded in a flask that could be handled by two men, since this would provide only a small amount of sand over the pattern. As a result, the molds for these castings, for several years, were made on a large molding machine at a saving of approximately 20 per cent over hand molding methods. The large flasks used provided ample sand room and the mold was gated at the joint. However, these large flasks had to be lifted with a crane, which materially increased the molding time. To effect further economies it was decided to mold this pattern in standard flasks of a smaller size, which could be handled by two men. To do this, however, the gating had to be changed, as indicated in Fig. 2, which is a cross-section of this mold made in smaller flasks.

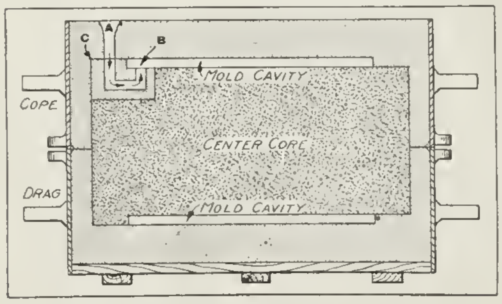


FIG. 2—CROSS-SECTION OF PISTON VALVE BUSHING MOLD

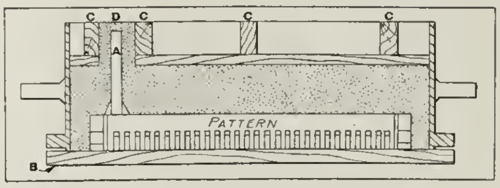


FIG. 3—CROSS-SECTION OF DRAG FOR ROCKING GRATE MOLD

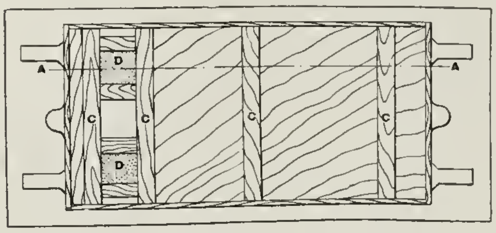


FIG. 4 — REVERSE SIDE OF DRAG, SHOWING CONSTRUCTION OF BOTTOM-BOARD

A gate core was rammed into the main core when it was made. This gate is shown at *A*, Fig. 2, and enters the mold at *B*. The method of gating was an important factor in making it possible to use the smaller flask for this job and better castings were produced as a result of this change. Also, a saving of 80 per cent in the cost of molding was effected and the castings were cleaner, freer from slag, dirt and blow-holes than when they were made in the larger flasks.

Another instance illustrating the use of shallow flasks in preference to deep ones, is shown in Figs. 3, 4 and 5. Rocking grate castings, Fig. 5, have a lever attachment to effect the dumping of the fire and these are of such a length that they necessitate the use of a deep drag flask requiring an excessive amount of sand, making the flask too heavy for two men to carry. In this case a bottom-board was constructed, as shown in Figs. 3 and 4. When making the mold, the mold board, *B*, is placed on the table of the machine with the patterns in position, the flask is placed on the board and only a sufficient amount of sand is filled into the flask to cover the main parts of the pattern. The bottom-board, as shown in the cross-section of the mold, Fig. 3, then is lowered into the flask. If this mold is made on a squeezer machine, the ramming head is pulled over, the mold is squeezed, the head is thrown back and the pockets are rammed by hand. If the mold is made on a jar-ramming machine, the bottom-board is set down into the flask after the mold has been jar-rammed, and then the pockets are rammed by the further operation of the machine. While this method involves another operation, namely, the hand-ramming of the pockets, never-

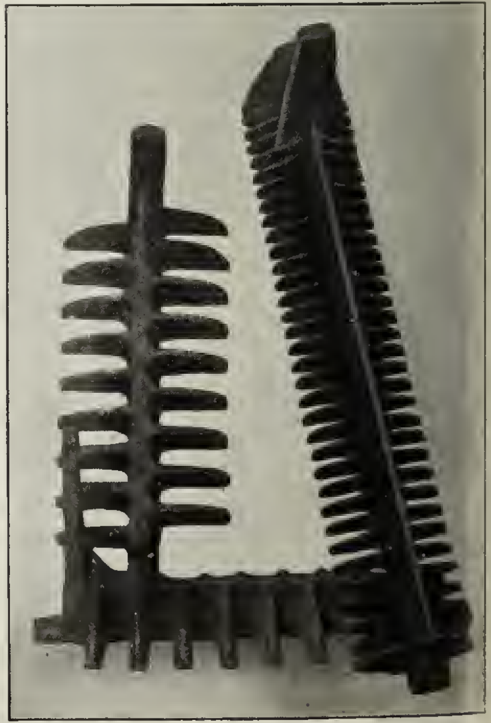


FIG. 5—ROCKING GRATE CASTINGS FOR LOCOMOTIVES

theless, the reduction in the amount of sand shoveled and in the weight of the molds more than compensates for this extra work. Fig. 3, which is a cross-section of this mold, shows the drag rammed ready to be rolled over. The shaking lever is shown at *A*. The pocket in the board that takes care of the lever in the mold is indicated at *D* and the height of the cleats on the bottom board, shown at *C*, is regulated by the depth of the flask and the quantity of sand desired in it. Fig. 4 is a view of the flask ready to roll over, showing the reverse side of the bottom-board and the pockets at *D*. This is an effective method of making castings of this design, since their quality is improved and the narrow pockets prevent swells on the lever. Wheels with long hubs and castings with long arms can be made at an extremely low cost by this method.

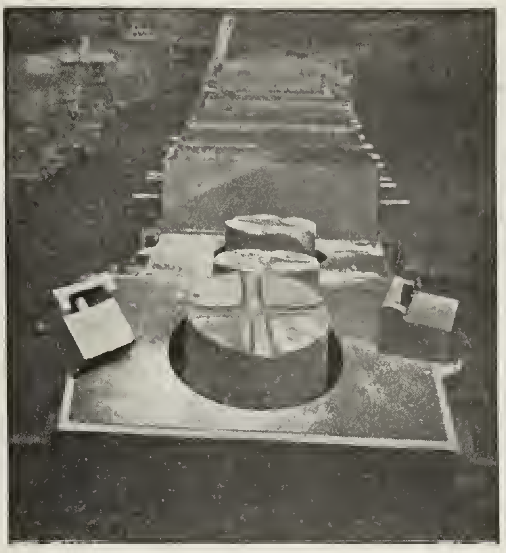


FIG. 7—PACKING RING MOLDS, SHOWING METHOD OF GATING

Packing rings are rather deep castings yet they can be made in shallow flasks at a decided reduction in the molding cost and this method also permits the use of standard flask equipment. Six of these castings are shown in Fig. 6, which must be free from defects, necessitating great care in ramming. To produce the drag half of these molds a mold board was constructed which permitted the pattern to drop down into it, as shown in Fig. 8. When the flask is placed on this board and filled with sand, the inside of the pattern is rammed to its full depth and only one-half of the outside. This, therefore, reduces the required depth of the drag and makes it possible for two men to handle the flask, thereby eliminating the use of a crane. A split pattern also could be employed to accomplish the same thing, but unless the pattern were split lengthwise and a dry sand core were made, the amount of securing necessary to hold the cope in position would offset the saving effected by the use of a shallow flask. To make the cope for this mold a stripping board was devised, as shown in Figs. 9 and 10. Fig. 9 is a cross-section of this board, the cope pattern being indicated by *A*, the stripping board by *B*, and *C* is the pattern plate attached to the molding machine frame.

The four lugs, *E*, Figs. 9 and 10, were formed with cores placed in the flask against the pattern before the cope was filled and rammed. This eliminated the labor required to secure the cores and disposed of the fins between the green sand and the cores. The mold

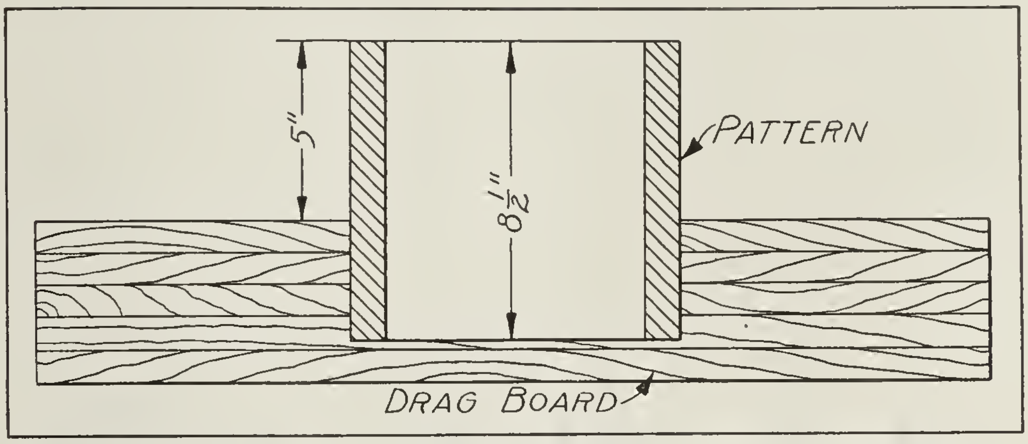


FIG. 8—MOLD BOARD FOR PACKING RING WITH PATTERN LOWERED INTO IT

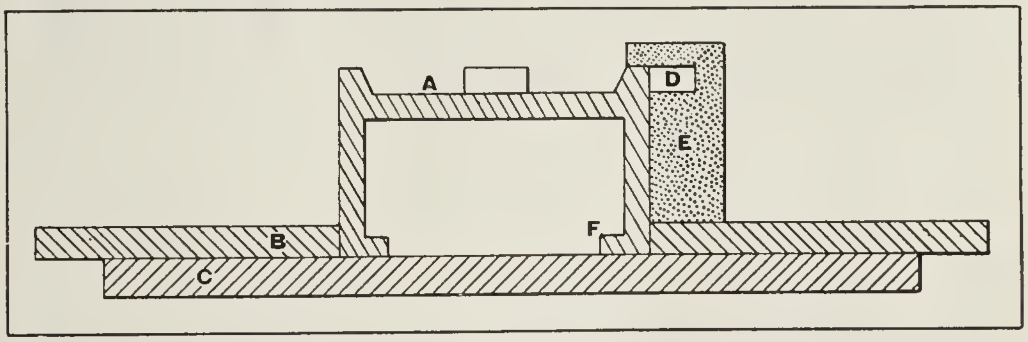


FIG. 9—CROSS-SECTION OF THE COPE PATTERN

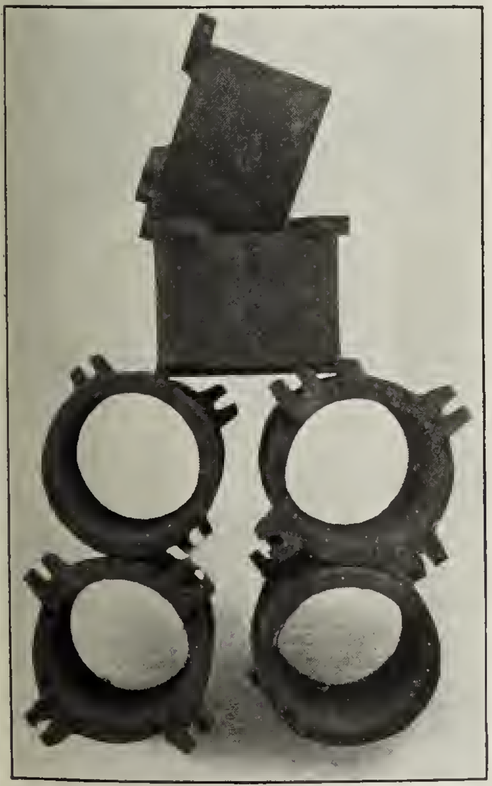


FIG. 6—PACKING RING CASTINGS

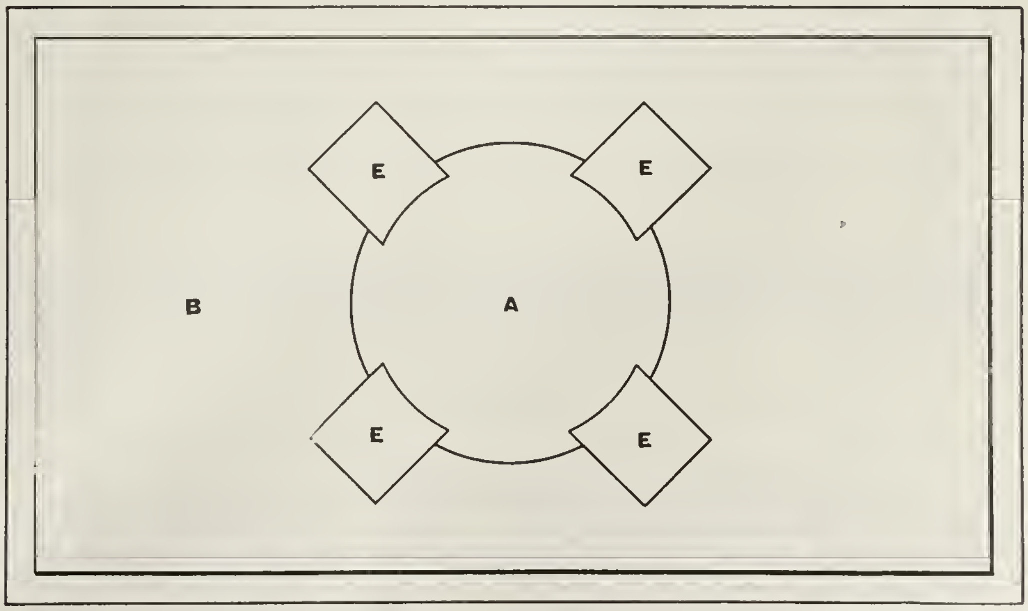


FIG. 10—COPE PATTERN AND STRIPPING PLATE WITH CORES FOR LUGS IN POSITION

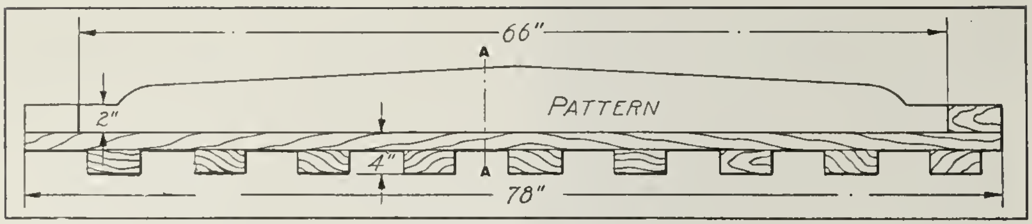


FIG. 11—LONGITUDINAL SECTION OF FOLLOW-BOARD AND PATTERN FOR GRATE BAR

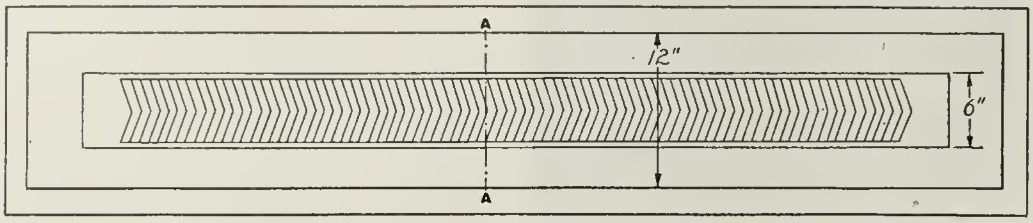


FIG. 12—PLAN VIEW OF GRATE BAR PATTERN

is gated in the center on top of the green sand core, as shown in Fig. 7. This method permitted us to use a standard set of flasks only 8 inches deep, but if the rings had been molded in the regular manner, a flask not less than 14 inches deep would have had to have been used.

Ordinary grate bars, as shown in Fig. 18, also can be molded in shallow flasks. Two ribs on these bars are wide and require a deep drag flask to take care of them. To make it possible to produce these castings on a molding machine, the follow-boards were so arranged that it was possible to mold a part of the bar in the cope. Fig. 11 is a longitudinal section of the follow-board with a pattern in place ready for receiving the flask. A plan view of the grate bar pattern is shown in Fig. 12. Fig. 13 is a cross-section of the follow-board and pattern and Fig. 14 is the same cross-section with the flask in position ready to receive the sand. A cross-section of the drag mold is illustrated in Fig. 15. At *A* is shown one of the small green sand cores, which extends above the joint, affording the machine operator an opportunity to repair the mold or to blow out any dirt that may fall into the small spaces between these green sand cores. By this method it was possible to successfully make these molds by machine. The cope was made on a stripping plate, while the drag was made on a jar-ramming machine. A longitudinal section of the cope mold is shown in Fig. 16 and the drag in Fig. 17. By molding the entire pattern in the drag, there was less strain on the deep flanges, less sand was required and the mold was handled more easily than by the previous method pursued. While the depth of the cope was greater than if the entire pattern were in the drag, nevertheless the total depth of drag and cope was much less than that of flasks which are considered standard equipment for this kind of work.

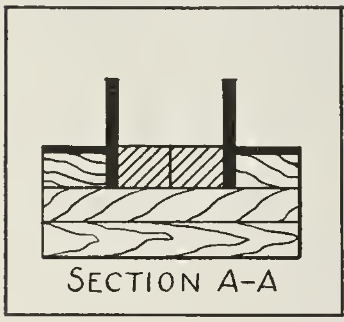


FIG. 13—CROSS-SECTION OF FOLLOW-BOARD AND PATTERN

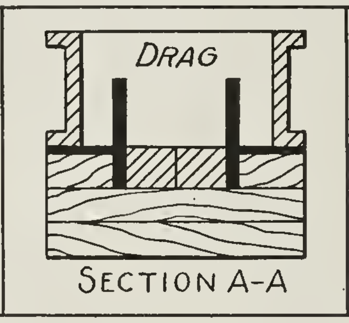


FIG. 14—CROSS-SECTION OF FLASK ON FOLLOW-BOARD

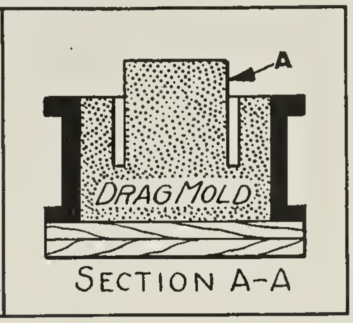


FIG. 15—CROSS-SECTION OF THE DRAG MOLD

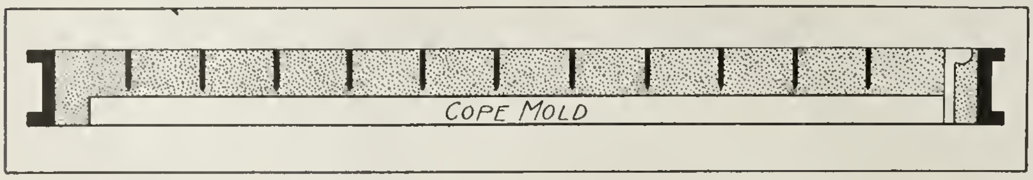


FIG. 16—LONGITUDINAL SECTION OF COPE MOLD

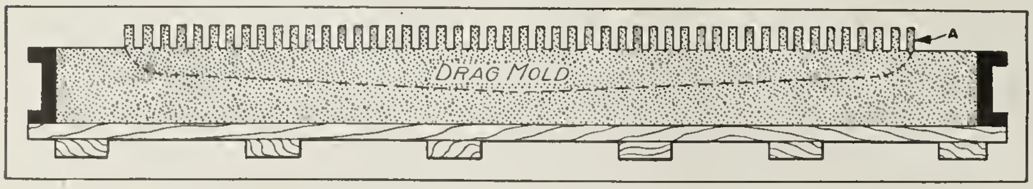


FIG. 17—LONGITUDINAL SECTION OF DRAG FOR GRATE BAR MOLD

Loss in Melting

By W. J. Keep

Question:—We use agricultural scrap almost entirely and we would like to know what the melting loss should be. We estimate it at about 10 per cent.

Answer:—You are doing very well if your loss does not exceed 10 per cent day after day. It is almost impossible, however, to ascertain exactly the losses in melting scrap, since there are so many chances for error with a mixture of pig and scrap. The loss generally is about 5 per cent, but the sand on the pig is a considerable part of this. However, if the scrap is clean, you may not have a greater loss than 5 per cent.

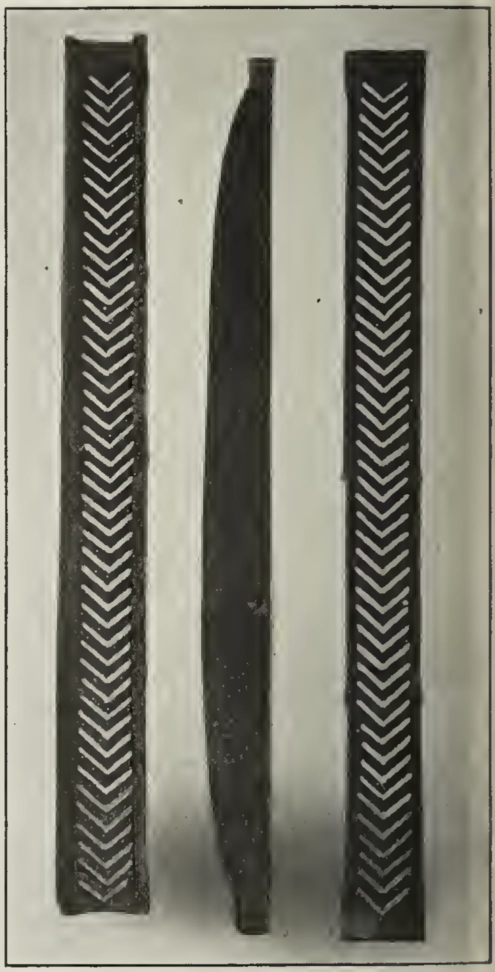


FIG. 18—GRATE BAR CASTINGS

The Pangborn Corporation, Hagerstown, Md., manufacturer of sandblast equipment, has taken over the business conducted by Elmer E. Perkins and George A. Cooley, Monadnock building, Chicago. Mr. Cooley will join the forces of the Pangborn Corporation, while Mr. Perkins will continue to handle condensing dryers and dry kilns.

Electric-Arc Welding for Foundry Purposes

A Few Practical Applications of this Economical and Convenient Method of Construction and Repair in the Foundry

By R R Clarke

THE progressive foundryman is always on the lookout to find in development along other lines, some detail of progress or novelty of experience that might profitably apply to some phase of his own endeavor. He is quite conscious of his dependence on men of other callings for many of his own needs and realizes that any announcement of progress, along any line however angular to his own, is liable to involve a suggestion, a probability of decided benefit to him if properly applied.

Opportunities for Electricity

A discovered or developed advantage along any line is, in application, perfectly legal property to any other, and the possible benefits thus admitted to the foundryman are such as to justify a watchful policy in general. The man of most any calling will do well to watch electricity. In that field are located many surprising features of modern progress and possibility. It is practically in its youth. What has already been accomplished in its application to industrial service is merely suggestive of what remains for accomplishment. Nor is the foundry by any means out of contact with its stronger currents of possibility. The problems to which it may prove a medium of solution, the difficulties it may dissolve and the practice to which it may attract change and increased efficiency as it becomes better understood and applied are found in foundries everywhere. Consider the facilities in equipment to which as a heat-producing agent it holds great promise. We have always dried cores in large ovens by means of coal and coke, air and oil or gas combustion, suffering more or less inconvenience in controlling temperature and considerable undue expense in maintaining fuel costs as well as labor incidentals necessary to continued use of certain fuels. Could we dry those cores in a battery of small ovens or larger ones for that matter, built to suit our individual requirements and operating either independent in conjunction with each other, by simply making a contact or increasing or reducing an independent current to the degree of realizing a specific heat in immediate demand? Could we thereby, without shifting from lower to upper shelves, start our cores drying slowly under low and proper temperature and run them slowly through all degrees of temperature essential to most pronounced efficiency in baking cores? And after those cores are baked, could we, to avoid burning them and to permit them to cool slowly with the gradual recession of supplied heat, merely turn off or reduce a current instead of shifting them around or taking them out of the oven on burning hot plates? We heat irons in furnaces, build fires, burn gas jets and resort to quite a few other inconvenient methods of drying molds. What could we do with a resistance coil?

We jar the tables of our machines, swing the cumbersome parts of machines into different positions, press sand in flasks, and draw patterns by hand, compressed air or reciprocating parts of shaft-driven machinery. What might the magnet have to offer along these lines? When a piece of flying steel or iron embeds itself in a man's eye, we march him up to the magnet. What might be possible to the magnet in drawing our core-rods and wires from our heavy brass and bronze castings—without bending and twisting those wires and rods into all kinds of shapes? In part these ideas may appear in advance of applying facilities, hampered by limitations not yet outbounded. Largely they are merely suggestive and representative of promising possibilities, in no wise ephemeral. Time was when we tediously picked iron from brass turnings, filed and chipped at returned scrap castings to determine presence or absence of iron screws, bolts, plugs and the like, hauled our different metals and castings around on wheelbarrows and man-drawn wagons, etc. Electricity has changed all this. With tremendous advantage we now inherit as an actuality the magnetic separator, the magnetic iron detector and the electric motor truck. Are we to consider such things as these the all of it or look on them as mere criterions of greater things yet possible? These are questions the great majority of foundrymen have yet to answer in a practical, applied way and they may do well to accord them serious analysis as the possibilities and applications of electricity become more and more understood.

One of the more revolutionary practices with which this modern servant has divested our industrial experience is electric arc-welding. It has not invaded this field of service alone, being contemporary therein with the thermit, the autogeneous and other processes. What its merits or demerits may be as compared to these other processes in general is an argument into which this discussion is not attracted. Each process being admittedly preferable to certain classes of service by virtue of its peculiar adaptability to that service, it suffices to say that the electric is not without its own broad element wherein it will operate with maximum efficiency and facility.

Principles of Arc-Welding

The average foundry can use an electric welding outfit in many and diversified instances and along varying lines of service. A brief insight to the principles of the process may be found attractive to general interest and value. If, through a closed circuit medium of prime conductivity a current of electricity be unobstructedly passed, that current will occasion little or no heat at any point of its passing. On the other hand, if that medium be inherently low in conductivity, or so shaped or formed as to arrest the progress of the current, or disconnected at any point so as to admit a slight intervening space, the passing current will then have to contend with a resistance, from which as a consequence heat perceptibly develops. The principle finds practical application in the resistance coil as existing in different every-day commodities and the incandescent light bulb where the heat reaches incandescent intensity.

If two conducting mediums be placed in close proximity with little open space between them and a strong current be sent through the one, the current will travel to the open space, encounter the resistance occasioned by the low conductivity of the atmosphere, tear through it and light on the opposite medium. In leaping the gulf the line of motion is not straight, but bowed or arc like and the energy and its resistance so great as to develop an intense heat and a consequent brilliant light. From these phenomena we derive the term arc-light, arc-welding, etc., the light taking the form of the bow-like of motion and resembling an arc.

As indicated, great heat features the process affecting both ends of the broken circuit to the degree of fusibility, that is at the source of the arc in the one and its terminus in the other point of medium occurs a melting of fusible elements. Being in direct line of the currents' motion through the arc, fine particles of molten metal in the source are carried over and deposited in the molten pool on the other end. In transit these particles take the form of a spray and very likely represent the molecular if not the atomic state of the element.

How Welding is Accomplished

Technically, the supplying end of the circuit, that is the rod terminating in open space in direction of flowing current, is known as an electrode. Electrodes in arc-welding are of metal or carbon, the former applying to the lower, and the latter to the higher current. The carbon is also used for cutting, an example of which occurs in welding cast iron where a piece of cast iron held in the arc springing from a carbon electrode and terminating on the object of repair or construction, will fuse and blow into the molten pool existing at this terminus. This method can be resorted to when an electrode of a certain element is not readily available.

In fusing, passing through and depositing in the atmosphere, it is quite apparent that as in the case of naked molten metal, the fused material will be affected by oxidation. If the welding could be done in a vacuum—in the very premises and absurdity—better results could doubtless be had. As it is, the problem reduces to that of deoxidation; the same as in the molten metal case. Efforts are being made to take care of this feature in the preparation of metal electrodes. In the incandescent light bulb, the heat is generated in a vacuum and offers an excellent opportunity for the foundryman to convince himself of the evils of oxidation. With the current on and the light shining brightly, break the end of the bulb, admit the atmosphere and notice how quickly its oxygen reduces the fine carbon thread or metal wire, as the case may be, to a worthless oxide.

Briefly, the whole phenomenon of electric heat and all its practical applications rests in the fact that the interruption of the easy passage of a current through a conductor, produces heat in the conductor at the point of interruption. It follows when for a short space the conductor loses of its conductivity, when it suddenly diminishes in size, or when it admits a short section of substance or element lower in conductivity than its own. On this latter principle arc-welding is based. That the little resistance of the atmosphere could produce the magical effect of the heat developed may at first sight appear incredulous, but it must be reckoned with that this little resistance is invariably active, disputing the most infinitesimal unit of current progress and operating against tremendous volume and an energy all but infinite. At the arc in ordinary welding with the metal electrode the voltage ranges from 30 to 35 with the amperage approximating 100. The process admits practical application in fusing iron on iron, steel on steel, copper on copper, iron on steel, steel on iron and copper on iron and steel. With the alloys of common usage, complications generally arise and this particular feature will be considered later on.

Electric welding performs a task which ordinary forge welding cannot well accomplish. The presence of copper or copper-base metal has a detrimental effect on the welding properties of iron. By pitching a couple of copper pennies into a blacksmith's forge fire, his chances of getting a good weld on pieces of iron heated in that fire are practically eliminated. The same consideration applies to pieces of iron manipulated in or around copper-base alloys.

Every-Day Welding Problems

When the German-clay crucible through the instrumentality of the war became a thing of the past and the American product came forward as a substitute, we realized the necessity of keeping our furnace tongs in the very best of fitting shape and condition. Purchasing different makes of crucibles wherever obtainable we experienced variation in shape and were obliged to frequently reset the tongs. Because of the repeated resetting of the single pair of tongs which was delegated to this service, bad fracture developed at a critical point. The foreman blacksmith admitted his inability to repair the tongs and suggested that we try the electric welding process. We did and got a very satisfactory result. Besides filling in and building up around the crevice, we reinforced those parts that had scaled and burned away, building up with the inburned copper-base alloy more or less frequently. The tongs have been in continuous service several months, giving no evidence of weakness at the welded points.

To determine the merit of the process thus applied and independent of any chance element that might have entered into this particular case, we took two strips of ordinary ⅛ x 1-inch wrought iron, immersed them in a pot of molten bronze, permitted the metal to burn on and into them and after cooling delivered them to the arc-welder. There we placed the two ends together and had them welded. As an efficiency test we placed the one end of the welded strip in a vise clamping a short distance from the welded joint and bending to right angles with hard and quick blows from a hammer. The welded joint participated in the bending but gave no evidence of breaking and left us quite satisfied that the often advanced claim of 80 per cent original strength is conservative. This assurance prompted a searching inquiry into those items of furnace equipment susceptible to the advantages of the process and led to a surprising revelation.

Repairing Tongs

Tongs of all kinds are repaired by this process. When a pair burns away and weakens it can be built-up and strengthened. Should any section break or crack, the crack can be welded shut, or the broken-off part recovered or a new section made and welded to the tongs. The same consideration applies to hooks, chains, bails, shanks, furnace-cleaning bars, stirring rods or skimmers, rings, links, etc. Often a broken link or ring in a pair of lifting tongs can be repaired without even taking the tongs apart. Two cleaning bars or skimmers shortened by use to uselessness can be laid end to end and the equivalent of a new one quickly and cheaply realized. When carrying-tongs or shanks crack in the circular band or the guards start to break away, no drilling, countersinking, patch-cutting and riveting are necessary; arc welding is better, neater, quicker and cheaper. Even in the making of the shank, time and expense can be saved. The guards are not inseparably necessary to the forging process. Shank and guards can be forged separately and later welded together. Building up parts as they become depleted at points of greatest wear offers a splendid opportunity. The wearing points of the ordinary carrying-bail may be built up as they approach the limit of safety in a cheap and efficient manner by the electric process. S hooks and all lifting or carrying appliances may be repaired in a similar way.

While going over our furnace equipment recently and in the interests of assured safety—something every foundry ought to do in a uniformly periodical way—we discovered the forged link attached to the end of the piston rod in the air hoist badly worn at the bottom. The wearing away had been confined to a very limited area and had formed a pocket. This pocket was built up and the lower part of the link reinforced all around, thus saving it from the scrap pile. In the future, new links of this kind will be made by the arc-welding process. An oval disc is cut from a plate of ⅝-inch boiler steel. A center hole and two side holes are punched or drilled and the side holes are countersunk on both sides of the disc. A short piece of good round merchant steel is bent in a *V* shape, the ends of the *V* are placed in the side holes of the disc, the upper ends being flush with upper side. The steel is then welding around the bottom and top countersinking, the top filling is filed flush, and the job is complete.

Another example of economy recently suggested itself. In holding tile lining to the iron furnace lid we resort to a square washer nut, a top nut and a stud threaded at both ends. One end of the stud is screwed and riveted into the washer nut, giving the effect of a flat-headed bolt. By punching a little larger hole in the washer nut, admitting the stud unthreaded and extending it to within ⅛-inch of being flush in the washer, the joint can be electric welded, thus eliminating threading one end of the stud and tapping the washer, and gaining the advantage of a solid-headed bolt.

Avoid Carelessness

In arc-welding, as in any repair work, the operator must use care to insure a safe job. Around furnaces and metal manipulating equipment no chances should be taken. The electric arc weld, in common with nearly all other methods of repair, admits the possibility of inefficiency and a hidden weakness. The last applied unit of forge heat may burn the iron, the last blow of the hammer may weaken a rivet, the last turn of a wrench may twist the bolt, the last spark from the electrode may impair the weld. Where strength and safety are of paramount issue and judgment wavers on unstable bases of decision, banish all considerations except strength and safety. Further, no such item of repair should enter routine service in advance of an exacting test on its qualifications, a principle well-applying to all conditions of equipment installation, new and old or repaired alike. Practically all other phases of foundry effort are equally susceptible to the advantage of the arc-weld. The flask frame, which is used to secure extra heights and depths in cope and drag to accommodate unusual patterns may be made by the welding process. Frames 1 and 2 inches in height are convenient in size. Common merchant flat iron stripping from 1/16 to 1/8-inch thick is cut into lengths slightly exceeding the perimeter of the flask.

Altering Flasks

A pattern is made and a cast frame whose perimeter (outside measurement) is slightly less than the outside perimeter of the flask but greater than the inside is roughly molded. The middle points on one end of iron frame and the iron stripping are marked. The stripping is heated, clamped onto the frame middle point to middle point, and bent around the frame, both ends almost meeting at the middle of opposite side. A thin sheet of asbestos is slipped between the cast iron frame and the ends of the stripping. While the ends are firmly held in place, a union is electrically welded. The welded frame can then be removed from the form. Small pieces, say 1¼ inches long, are cut from 1/16 x ½-inch stripping and welded to the frame at the most advantageous points, allowing for about a ⅜-inch projection. The projecting ends may be filed to a slight taper to facilitate placing the frame on top of the flask. After the welded union is roughly dressed, a commodious flask frame of maximum durability has been completed at a very low level of producing cost. The form for bending the iron into frame shape can also be realized by screwing some half-dozen studs into a smooth-surfaced iron plate, one stud at each corner of the square and one at the middle point of each side. A flask itself can be made the base of the form by attaching iron strips at these points, inside position in the flask being understood. Electric welding may also be used to make sheet iron snap-mold bands, whether of the slip-pocket variety or of the cope and drag type, separately set in the snap frame when ramming up the mold. These bands are used in heavy work, where the metal pressure overtaxes the mold sand resistance when unsupported. They can be very neatly and cheaply made by bending the sheet iron to proper shape and dimension and welding a union.

At this juncture the question of welding the broken flask, instead of patching it, naturally arises. If the flask be of steel, the opportunity is an excellent one and applies to any detail of construction or repair such as attaching parts, joining adjacent sections, repairing fractures and burn-outs, strengthening weak places, etc. If it is desired that a flask be two or three times as deep as manufactured, two or three such parts may be clamped together and electrically welded, either in sections of union or in total. If desirable to permanently heighten a cope or deepen a drag by an inch or two, the frame may be welded at little expense.

Much has been written about the advantage of the arc-weld in saving defective castings by welding shut or filling in the cavities of defect as well as building up the shrunken surface. In the case of the steel casting, the electric process is distinctly applicable and practical. Large spokes in cast steel wheels in fracturing are electric welded to satisfactory purpose and with no sensible impairment to the wheel in subsequent service. A ruling very often observed, however, and one which illustrates a slight suspicion of the efficiency of the process is that no two adjacent spokes shall be so repaired. As affecting the non-ferrous consideration, it is thought that pure copper adapts itself to electric welding, but the casting made from a non-ferrous alloy of copper base has much to argue against the practice. Actual trials show that low degree melting elements in the casting burn out and that the electrode sometimes fails to furnish a properly filling-in supply. The appearance of the weld around the edges of the burn and even in its more interior surface is far from prompting enthusiasm. To properly tin a surface there must be proper temperature in both "tinning" surface and "tinning" instrument. To properly burn in a copper-base casting the same condition largely prevails and the heat of the arc cannot well be adjusted to the requirements in question.

Making Tumblers

Malleable castings may be satisfactorily repaired by the electric-arc process. Any parts of machines, shaft hangers, bearing and bearing caps in which the malleable is used offers an opportunity in so far as its susceptibilities to efficient union are concerned.

Electric welding proves satisfactory in both construction and repair work. The foundry tumbling barrel may be taken as an example. An efficient and handy method of constructing a tumbling barrel is to use cast iron heads and to roll a cylinder of heavy boiler steel into which the heads are riveted. At the end of the roll or where the two edges meet, a heavy buck-strap is firmly riveted onto the adjoining sections. In hard and heavy service these rivets invariably loosen, become worn in the holes and have to be replaced. The union can be effected to within at least 75 per cent of undivided boiler steel strength by means of the electric weld and the strap may be discarded. It is also good practice to use a number of straps fastened by only a few rivets, and then to electric weld all around the outside of the straps and over the seam from the inside. Either method will produce a better, neater and more lasting job at a much reduced figure than that of the complete riveting process. Large foundry supply bins such as those used for keeping flour, talc, plumbago, parting, crushed charcoal, lime, fireclay, facing sands, etc., foundry and coreroom boshes, and all such equipment can be readily constructed on the same principle. Often it is necessary to construct short furnace stacks out of fairly heavy material. It is expensive to build up a stack section by section through the medium of the rivet. This may be avoided by laying the sections together in a straight line and securing them with the electric weld. The dust guards for buffing to highly duplicated classes of chines, belt-shifting mechanism, etc., may be constructed or repaired by electric welding.

Often a circular core rod firmly joined together or a core rod longer than the longest of a similar assortment at hand is needed. The coremaker overlaps ends and binds them together with twisted wire. A touch of the electrode will give better and often cheaper results. Likewise, complex and difficult shapes of core rods mold sand anchors and jaggers applying to highly duplicate classes of work may be made.

Copper can be welded on iron by the electric process. Frequently a foundry is called upon to run copper-base metal on iron rods. To insure permanency in the position of the metal, grooves are cut in the rod in mistrust of the efficiency of the burn-on to meet the demands of the occasion. The rod is materially weakened by this groove-turning process. In doing this work by the arc-weld process, the rod is cleaned in the vicinity of copper-base metal. It is nicked all around with a cold-chisel, and patches of copper of consistent thickness are welded on this nickel surface. In casting, the copper-base metal should be poured at a conservatively high temperature. The copper patch adheres firmly to the iron, the pouring metal burns hard to the copper patch and the job is above suspicion so far as retention of position is concerned.

The process derives much of its efficiency from the knowledge and skill of the operator, experience being a great asset to successful manipulation. Anyone familiar with electrical principles and appliances in handling, can take the instrument, create an arc and make a deposit, but it remains for the experience-taught operator, with his artistic touch, sense of heat, and knowledge of current pressure and volume, to give the even, symmetrical surface appearance covering an efficient weld.'

Care should be exercised in preparing the parts to be welded. All surfaces should be made scrupulously clean, exposing untarnished metal as far as can be realized. *V* shaped grooves of amply spacious dimensions should be cut along the line of all crevices or fractures, and holes should be explored to their bottoms for evidence of corroded or slowly oxidizing metal. All adjoining edges to be seamed together should be champered as far as practical to afford the arc greater depositing surface and volume. Only the best depositing material obtainable should be used.

Chill Cracks in Lathe Beds

By W. J. Keep

Question:—We cast our large lathe beds with cast iron chills about 4 to 5 inches long, laid end to end the entire length of the bed. Where the chills join, cracks about ½-inch deep extend in from the edge about 1 inch and down about ½-inch. We are using the same method of molding as previously and we have not changed our iron mixture. The analysis of the iron in the casting is practically the same. We have tried leaving the casting in the sand over night until it is thoroughly cooled and other methods common to foundry practice. Do you think using a thinner chill would help? These cracks are hardly noticeable and appear after taking off the first cut.

Answer:—You say that the analysis of the iron in your castings is practically the same as when you had no trouble. Probably a closer examination of such analysis will disclose the trouble. Ask the advice of the chemist who makes the determination. Less silicon or greater sulphur would produce the result. In these times pig iron or coke or limestone cannot be depended upon. Probably the trouble is not in the pig iron or scrap. If the coke has higher sulphur, it will go into the iron. Pyrites in limestone that cannot be seen except by wetting the stone, will impart nearly all of its sulphur to the iron. What you may consider practically the same may vary in a manner which will produce the result. If all the conditions are the same, the result will be the same. The process of chilling is instantaneous and the crack occurs before the iron is set in unchilled portions. A chill produced by higher sulphur is a weak chill. As soon as the iron strikes the chill, it becomes solid and shrinks the whole length of the bed, but some roughness in the chill surfaces does not allow the whole to pull in from the ends. It would not anyway in your case, but the portion lying on each chill must be treated independently. You have each surface 4 inches long becoming solid and shrinkage instantly about 0.01-inch. The iron has very little strength and pulls apart at the junction of two chills. Such a crack may make the bed unsalable, but is not usually a line of weakness because it occurred before the iron set behind the chilled part and all strain was removed. Your chill surfaces should be smooth and lie close together so as not to leave a thin film of unchilled melted metal at the junction. In some way decrease the amount of shrinkage just enough to prevent the crack. First, be sure that sulphur is as low as 0.07 per cent or less. Keep the phosphorus low, say 0.05 per cent, so that the iron will set quickly, with the manganese about 0.05 per cent to lessen the total shrinkage. When all this has been done, increase the silicon until the cracks disappear. I would not make the chills thinner or treat the solid casting in any special way. A casting with a chilled long surface has a strain the entire length and should be handled carefully, with no jar in moving, and the longer it can stand before machining, the better. Seasoning allows the grains to adjust themselves and remove the pull in the chilled surface.

The Mott Sand Blast Mfg. Co., 893 East 134th street, New York City, has just completed a new plant at Brooklyn, N. Y. The new quarters have been especially fitted up with facilities for manufacturing sand blasting and allied equipment on which the company has specialized.

Joseph Harrison, formerly foundry superintendent of the Allis Chalmers Mfg. Co., Milwaukee, Wis., and for the last several years Milwaukee representative of the J. S. McCormick Co., Pittsburgh, foundry supply dealers, died recently at his home in Milwaukee.

Systematic Pattern Storage Aids the Foundry

Well Arranged Storage Facilities and a Simple but Comprehensive Record of Patterns are Principal Requisites

FIG. 2—A SPACIOUS BUILDING IS AN AID TO GOOD STORAGE

A TENSE air of expectancy dominated the dingy office of the International Castings Co. Chapman, the core room foreman; Ashland, the chief patternmaker; Elsey, the head draftsman; and O'Malley, boss of the molding floor, anxiously waited for the superintendent, Randall, to state the reason for his hurried summons.

After carefully extracting a few papers from the multi-colored assortment on his desk, Randall swept the faces of his audience with a critical eye and then plunged into the subject of the meeting.

"Something is radically wrong with our organization. We are losing altogether too much time hunting for patterns. Listen to this:"

Picking up a telegram from the Universal Engine Co., he read:

"Rush five hundred gray iron castings, our pattern three six two nine. Pattern sent January fifteen, nineteen sixteen, for previous order."

"Now although we made 100 of these castings only a few months ago, none of you gentlemen were able to locate the pattern. We looked high and low, and I venture to say that the time spent in trying to locate the missing pattern was worth at least $50 to this company. After waiting a day, I was obliged to wire the Universal people for a drawing so we could make another pattern. Listen to their reply."

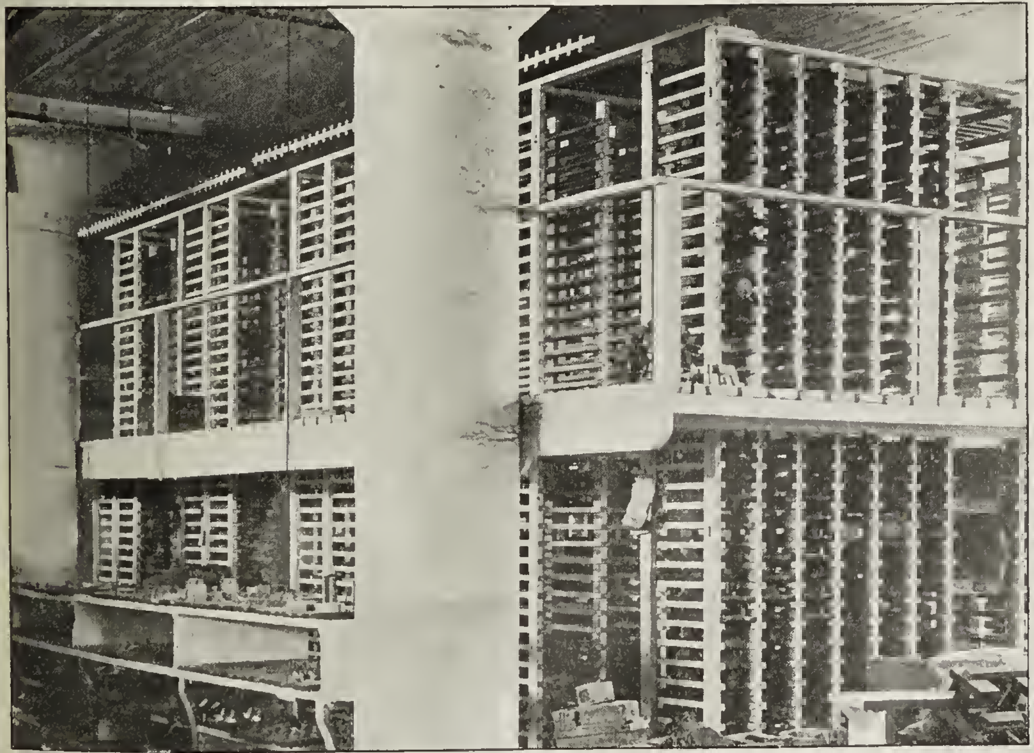


FIG. 1—MACHINE PATTERN PLATES ARE STORED ON NUMBERED SLIDES

"Cancel order, cannot wait for new pattern, letter following."

Randall picked up a letter from the desk and passed it to the foremen. They read:

International Castings Co.,
Pleasantville, O.
Gentlemen:

We regret that we were obliged to cancel our telegraphic order for 500 castings, our pattern No. 3629. The castings are required to complete a rush job for the government, and the delay which would have ensued if we had waited for you to make a new pattern would have made it impossible for us to fulfill our promise of early delivery.

Consequently we delivered a duplicate pattern to a local foundry which is in a position to fill our order immediately.

You will understand that our action is no reflection on the quality of the castings you have furnished us on past orders.

Very truly yours,
UNIVERSAL ENGINE CO.

"So you see, gentlemen," said Randall,

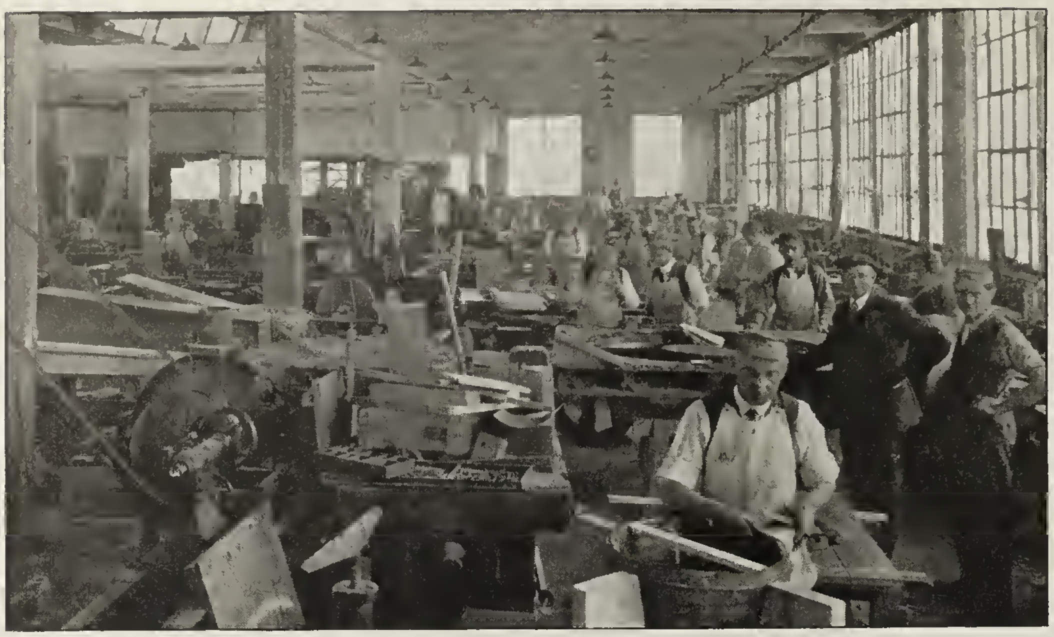


FIG. 3—EVERY PATTERN MADE IN THE PATTERN SHOP IS CARDED EVEN BEFORE WORK ON IT IS COMMENCED

"our lack of system in handling patterns lost us a mighty profitable job. All of our efforts to bring the quality of our catsings up to the present high standard go for naught in this case simply because our organization does not provide for keeping a reliable record of our patterns. What have you to say about this fall-down, Ashland? You're the man who is supposed to know where our patterns are kept."

"Well, I guess our system is a little weak", admitted the chief patternmaker. "You see we don't keep a record. We simply have a rack or bin for every pattern, and we chalk the number of the pattern on rack which holds it. If a pattern is missing, we take for granted it is in the foundry. We have had only a few cases where patterns have gone astray. The Universal Engine Co. pattern is the first one we have lost in a couple of months. I doubt if it would pay to keep a lot of records of our patterns."

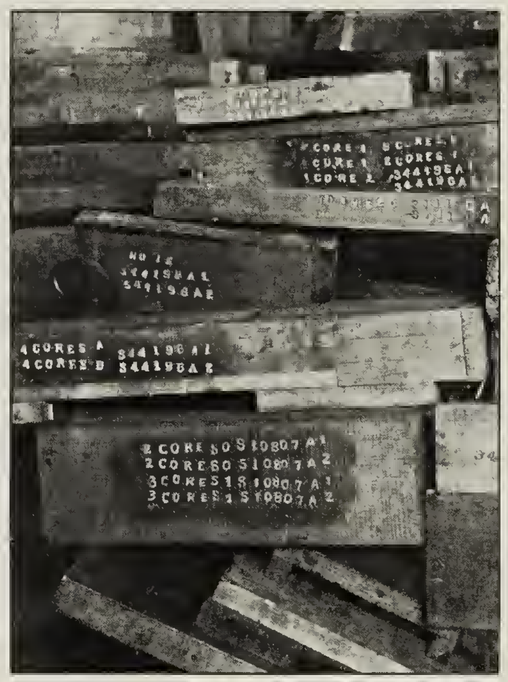


FIG. 5—STENCILED NUMBERS ASSIST IN IDENTIFICATION

"Wait a minute," broke in Randall. "You say you think it wouldn't pay. Why man, the money we lost on that Universal Engine deal would pay for the maintenance of a complete file system for a year! We are going to start a record of patterns, and we are going to start it today."

"Ashland, have your clerk make out a card for every pattern we have. When you deliver a pattern to the foundry, you charge it off the card. Elsey, when you make the drawing for a new pattern, send a memorandum to Ashland so that he can make out a card for it. Then, Ashland, you are to write on each card the number of the core box or boxes required with each pattern, and then go over the matter with Chapman so that there will be some sort of a check on core boxes for the core room and pattern storage department. O'Malley, when you return patterns to the storage department, give Ashland a list of patterns so that he can check them off the cards. A week from today I shall expect you men to come here and tell me how the new system is working. That's all for today."

* * *

It is almost unnecessary to state that in the course of a few months Randall's plan developed into a smoothly running system of records which saved the company many times its cost in improved service to its customers. If the average foundryman would face the pattern storage problem with determination, and would employ the effective measures adopted by the International Castings Co., there would be less embarrassment in promptly producing castings. So many foundries have neglected to systematically handle patterns that the

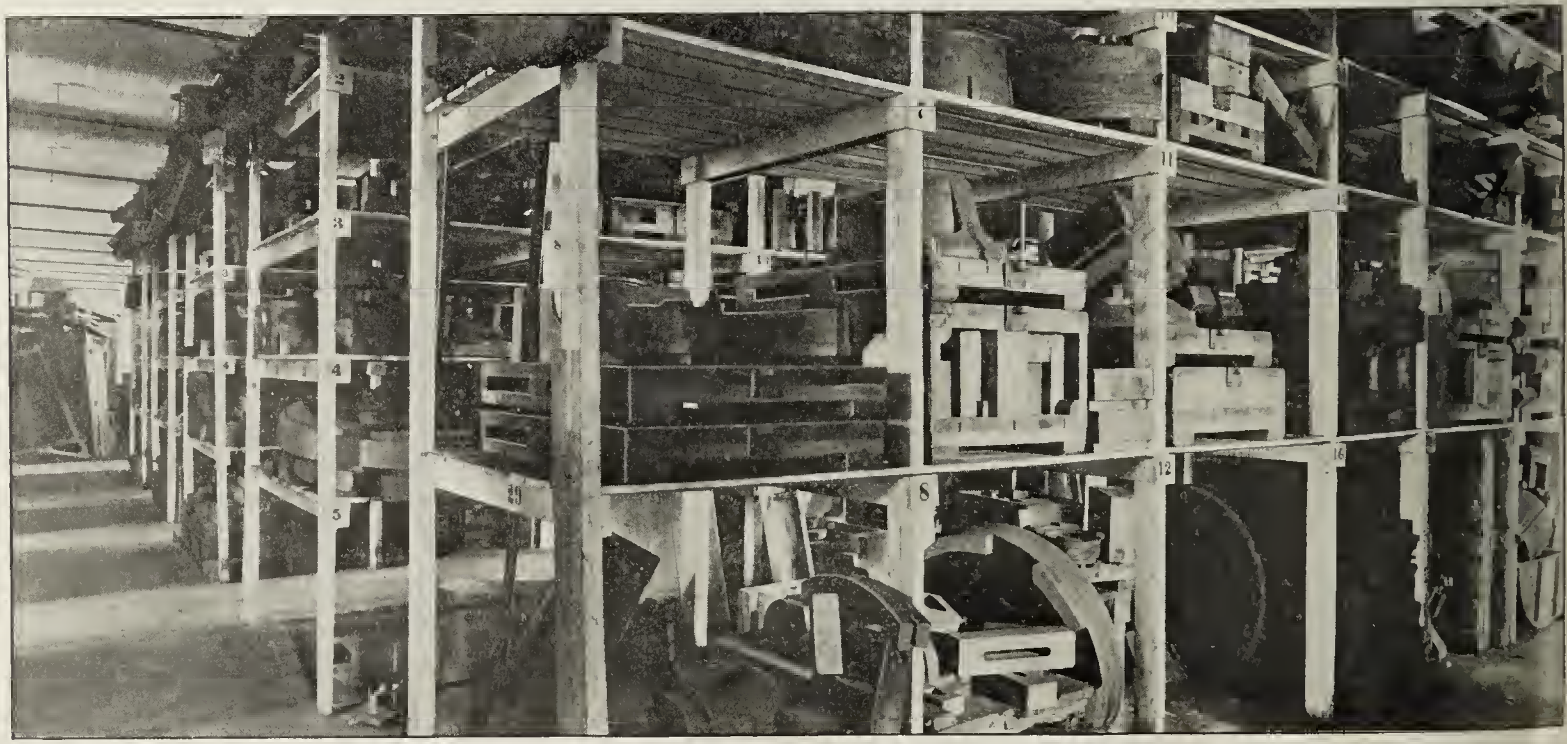


FIG. 4—PATTERNS OF MEDIUM SIZE ARE STORED ON NUMBERED RACKS

methods followed by a company which has successfully solved the problem should be of particular value.

The records maintained by the Cleveland foundry of the Westinghouse Electric & Mfg. Co. constitute a system which has proved highly successful in tracing the movement of patterns through the various departments of this extensive organization. The list of patterns, core boxes, pattern plates, and machine plates is so comprehensive and yet so simple that any one of over 50,000 pieces stored on seven floors of a large storage building may be found almost instantly by referring to the card file.

The present system is the development of a plan conceived when many of the castings used by the Westinghouse company were made at the old foundry at Allegheny, Pa., before the Cleveland plant was increased to its existing capacity. The original plan of numbering patterns provided for seven or eight series of 10,000 numbers, the numbers of each series having a letter prefix as *B*, *C*, *G*, etc. The numbers of each series were listed on 8 x 10-inch sheets bound in manila wrappers. Spaces were provided for marks to designate the location of the patterns in the storage racks, and for the dates on which the patterns were received from the pattern shop or sent to the foundry. When the Allegheny foundry was moved to Cleveland, the information on the sheets was transferred to a card file, the letter-prefix series being continued as before. Later another series with numbers running up to 50,000, and having no prefixed letter was started but before it was completed, the present scheme of numbering was adopted.

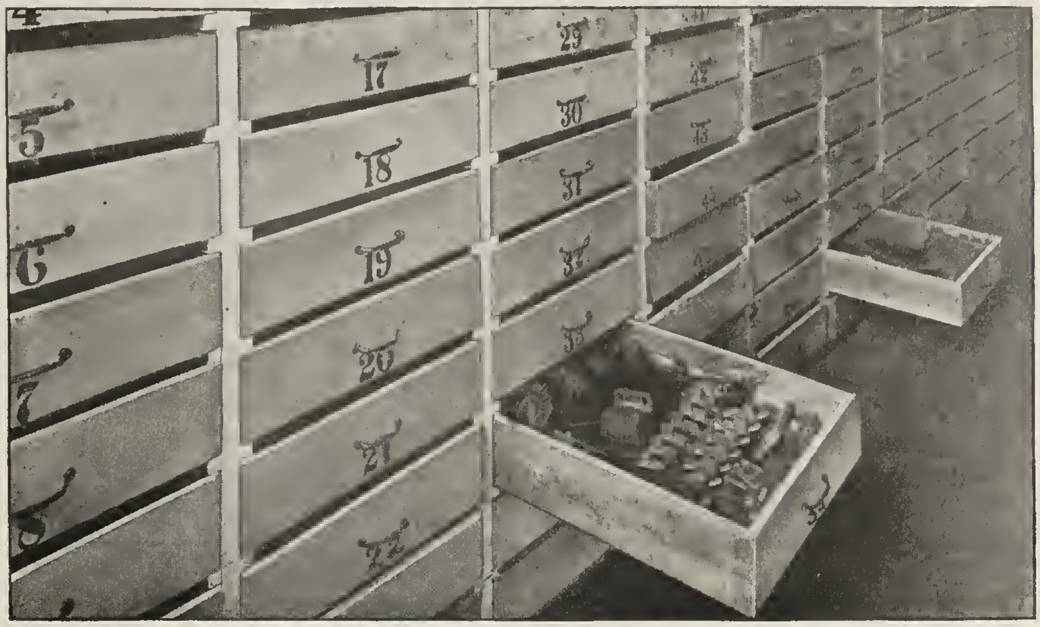
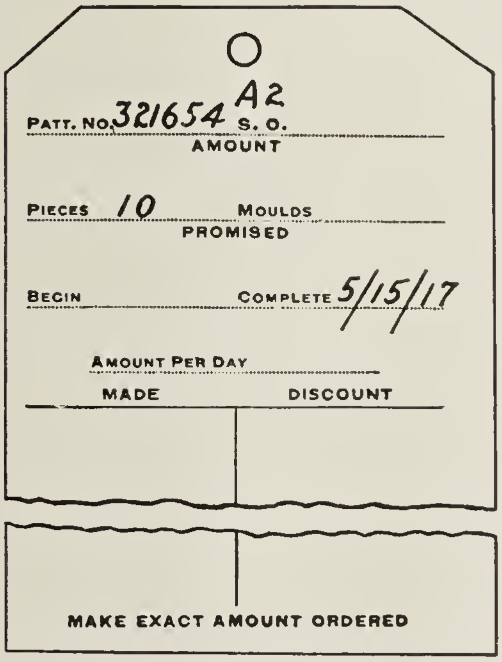


FIG. 7—SMALL PATTERNS ARE KEPT IN DRAWERS—SOME OF THE DRAWERS HOLD AS MANY AS 50 PATTERNS



O

PATT. NO. 321654 A2 S. O.

AMOUNT

PIECES 10 MOULDS

PROMISED

BEGIN COMPLETE 5/15/17

AMOUNT PER DAY

MADE DISCOUNT

MAKE EXACT AMOUNT ORDERED

FIG. 8 — A TAG ACCOMPANIES EACH PATTERN TO THE FOUNDRY

One of the disadvantages of the old systems, and the factor which prompted the change, was the existence of two complete and distinct sets of numbers for drawings and patterns. Under the old method of numbering, it was necessary to refer to a bulky volume of tracing numbers to determine the pattern shown on any particular blue print. If a pattern had to be replaced it was necessary to refer to a book to find out what blue print should be consulted. The inconvenience of this frequent procedure led to the adoption of the present series of pattern numbers.

The "six cylinder" series, as the new set of numbers is called, starts with 100,000. The pattern numbers correspond to the numbers of the drawings. For instance, if four patterns are shown on tracing No. 321,654, the patterns are numbered 321,654-A-1; 321,654-A-2; 321,654-A-3, and 321,654-A-4. When an alteration has been made in the tracing, the drawing number becomes 321,654-B,

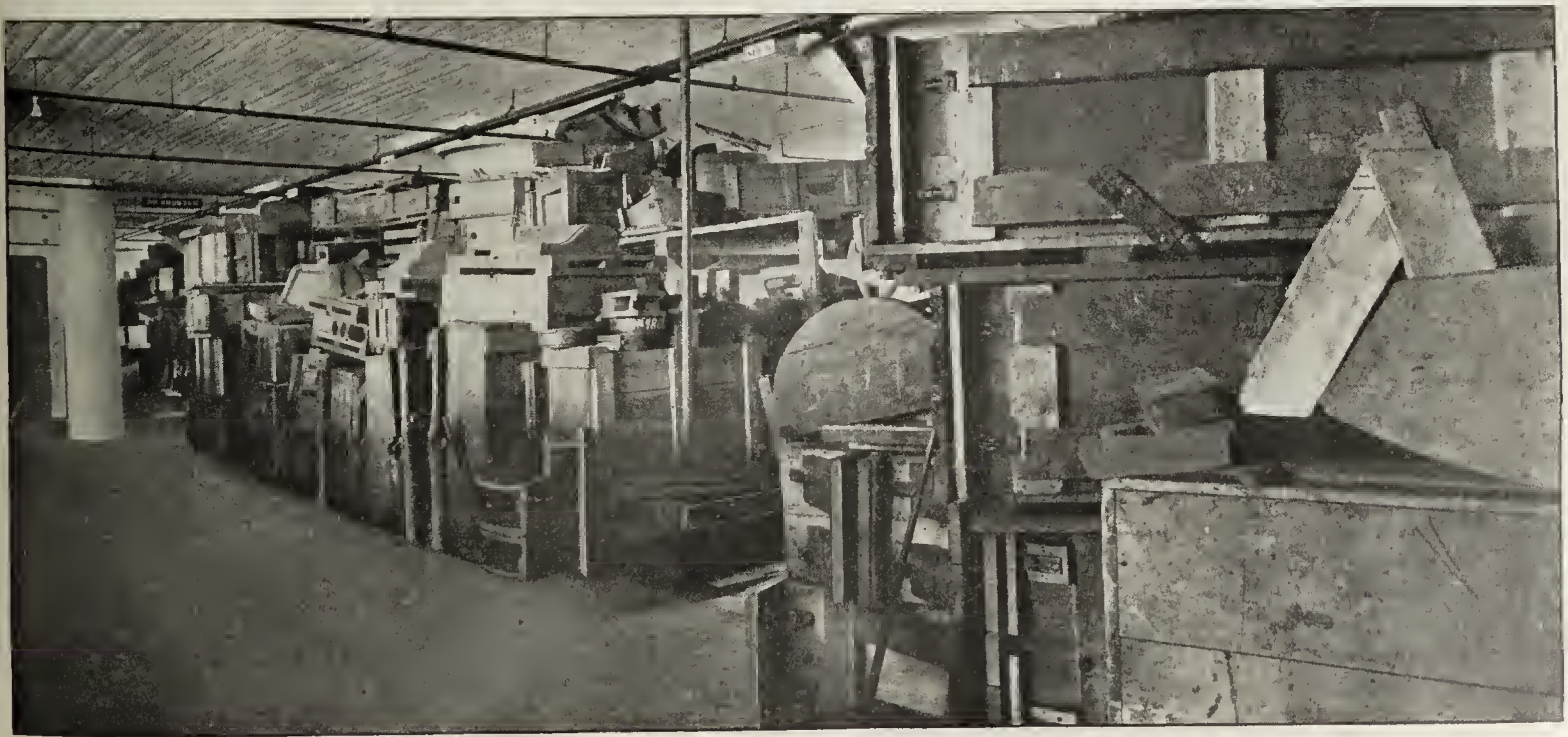
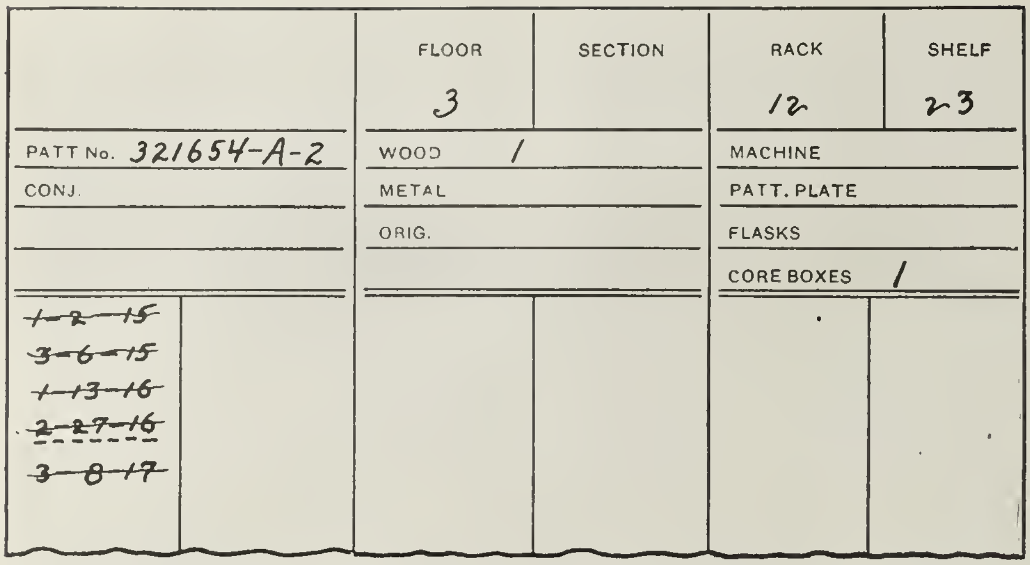


FIG. 6—LARGE PATTERNS AND CORE BOXES ARE GROUPED IN NUMBERED SECTIONS



FLOOR 3

SECTION

RACK 12

SHELF 2-3

PATT No. 321654-A-2

CONJ.

WOOD /

METAL

ORIG.

MACHINE

PATT. PLATE

FLASKS

CORE BOXES /

~~1-2-15~~

~~3-6-15~~

~~1-13-16~~

~~2-27-16~~

~~3-8-17~~

FIG. 9—FACSIMILE OF A FILE CARD—THE INFORMATION ON A CARD INDICATES THE MOVEMENT OF THE PATTERN THROUGH THE VARIOUS DEPARTMENTS

and the patterns for the altered casting are 321,654-B-1; 321,654-B-2; etc.

The card index, which is the keystone of the system of records, is kept in cases in an office on the first floor of the pattern storage building and is conveniently near the point where patterns are delivered to and from the foundry. Each file case is plainly labeled with the lowest and highest number of the cards it contains. New cards are made out by the file clerk when he receives a memorandum from the engineering department at the East Pittsburgh office stating that certain drawings have been prepared. When the pattern shop receives authority to make a pattern, a notation to this effect is made in pencil on the card. When the pattern is completed and delivered to the storage department, it is accompanied by a memorandum, and the file clerk erases the pencil notation and marks the location of the pattern in the pattern storage department on the card in the space provided. This is shown in Fig. 9, which is a reproduction of the file card.

Patterns are stored on the first seven floors of the eight-story pattern building which was described in the April, 1916, issue of *The Foundry*. The small patterns which might easily be lost if stored on shelves are kept in drawers as shown in Fig. 7. Larger patterns are arranged on racks as illustrated in Fig. 4. Medium-sized patterns are kept on the second to seventh floors, while the extra large patterns, bulky core boxes and other heavy parts are stored on each of the seven storage floors. The stories are connected by two spacious elevators and two wide stairways. The arrangement of the floors is approximately as shown in Fig. 10.

In order to facilitate finding a given pattern, the racks are numbered according to the system indicated in Fig. 10. Each rack is divided into compartments known as shelves. The numbering of the shelves is shown in Fig. 4. The large patterns and core boxes are grouped in sections, and each section is marked by means of a painted sign suspended from the automatic sprinkler pipes near the ceiling as indicated in Fig. 6. Pattern plates for machine work are stored in racks on the first floor as illustrated in Fig. 1. Each slide in the racks is numbered by a painted metal tag. The file clerk is assisted in finding all of the pieces used with each pattern by notations on the card which show the number of cores, loose pieces, etc., required. An effort is made to store related patterns, coreboxes, and all other parts on one shelf or in adjacent shelves.

When more than one pattern is required to make a casting or when one of several patterns may be used to make a given casting, these facts are noted on the face of the card. This is an essential provision, for it is often possible to make one pattern take the place of another by simply using different cores. Each core box, and many of the patterns are stenciled with numbers to show the various pieces required to make up the entire pattern. This stenciling is shown in Fig. 5.

Referring again to the file card, Fig. 9, space is provided for showing the type of pattern used. After the words, "wood, metal, machine, pattern plate, flasks, core boxes" are spaces for inserting the number of each of these items. For instance, the card shown indicates that the pattern is of wood, that it is in one piece, and that one core box is used in making the casting.

When an order comes to the foundry for a casting, a triplicate copy of the order is sent to the file clerk. The order shows the number of the pattern, the number of castings to be made, and the date when the castings are to be completed. The clerk copies the pattern numbers into a book, and then by referring to his card file, marks the location of the patterns after each number in the book. Attendants then consult the book, go to the designated rack or section, and carry the pattern and necessary core boxes to a receiving point near the file clerk's office.

In the meantime, clerks in the main foundry office have made out tags similar to the one shown in Fig. 8. Each of these tags shows the pattern number, the number of castings to be made, and the date promised for completing

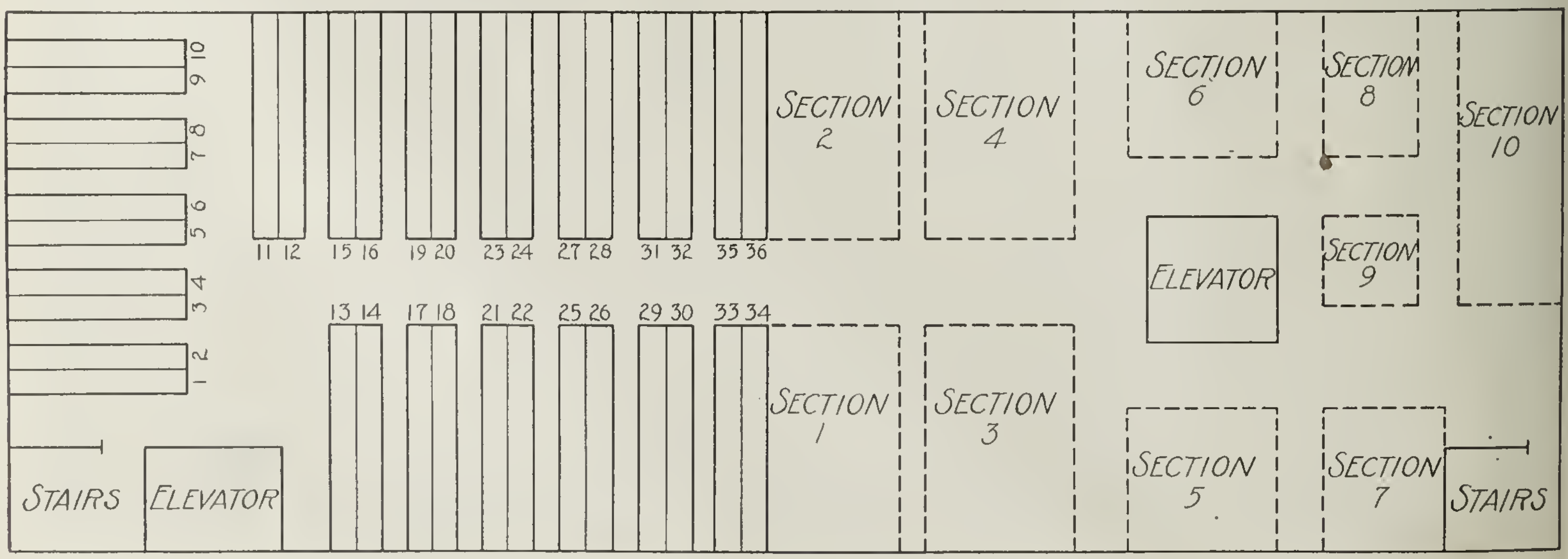


FIG. 10—ARRANGEMENT OF RACKS, SECTIONS AND ELEVATORS IN PATTERN STORAGE BUILDING

the castings. These tags are delivered to the file clerk, and as his assistants attach the tags to the patterns they have collected at the receiving point, the clerk writes the date in the space below the double line on the file card. The plain date indicates that the pattern was delivered to the foundry on the day indicated. When a pattern is sent to the pattern shop for repairs, a dotted line is drawn under the date. Thus the card shown in Fig. 9 indicates that the pattern was delivered to the foundry Jan. 2, 1915; March 6, 1915; Jan. 13, 1916; and March 8, 1917. It was sent to the pattern shop Feb. 27, 1916. If for any reason the pattern was shipped to the East Pittsburgh works, this fact and the date of shipment is noted. When a pattern is scrapped the word "scrapped" with the date of scrapping, is stamped on the face of the card, and the card is retained in the file to show the disposition of the pattern.

After the pattern has been used in the foundry, it is returned to the receiving point, and is accompanied by a memorandum from the foundry foreman. On receipt of the pattern, the file clerk refers to the card to find out the numbers of the core boxes and other pieces which belong with the pattern. His assistant then goes to the core room and collects the core box, and when all of the parts of the pattern have been collected, they are stored in the proper place in the storage rooms. The file clerk then draws a line through the date on the file card, thus indicating that the pattern has been returned and is again in its proper place on a certain floor of the storage building.

Experiments With Permanent Molds

By J J Howell

THE results of some important tests which were carried out in Herbert's Edgwick foundry for the purpose of making a definite comparison between gray iron cast in sand molds and gray iron cast in permanent molds will prove of interest to foundrymen. In carrying out these tests, three sets of test bars were used. The test bars were cast entirely from the same ladle of metal and as quickly as possible so as to eliminate any great change in temperature. The sand-cast bars were made in ordinary green sand molds. The permanent mold was of suitable design and was made of ordinary gray iron. The mixture used was an ordinary one, which is commonly used in the production of small parts for machine tools. In this instance it was made up of 600 pounds of Stanton No. 3 pig iron and 200 pounds of No. 1 Barrow hematite pig iron. The three sets of bars comprised bars cast in sand molds, bars cast in permanent iron molds, but not annealed, and bars cast in permanent iron molds and annealed. Chemical analyses were taken; transverse, tensile, Brinell and Keep's tests were made and microphotographs of each set of bars were taken.

Preparation of Test Bars

The transverse bars for the sand-cast samples were cast 1¼ inches square and 14 inches long. They were machined to exactly 1-inch square and were supported at 12-inch centers during the tests. The tensile bars for the sand-cast samples were cast 1¼ inches in diameter and 9 inches long and were machined suitable for a standard tensile-test bar. The bars for the tests of metal cast in permanent iron molds were made from sticks 1½ inches in diameter and 4 feet long; the annealed bars cast in permanent molds were annealed at a temperature of 800 degrees Cent. to 900 degrees Cent. for 20 hours.

In the transverse tests it was found that the bars cast in sand gave a breaking load of 2,250 pounds with a deflection of 0.130-inch. The bars cast in the permanent mold, not annealed, gave a breaking load of 2,325 pounds with a deflection of 0.110-inch, this being a slightly higher breaking strain with slightly less deflection than in the case of a sand-cast bar. The bars cast in permanent molds and annealed gave a breaking weight of 2,737 pounds with a deflection of 0.110 inch. Attention is called to the fact that although the sand-cast bars had a slightly greater deflection than those cast in permanent molds, the bar cast in the permanent mold and annealed stood no less than 23 per cent higher transverse strain than the sand-cast bars. With regard to tensile tests, it was found that the sand-cast bar stood 10.5 tons per square inch tensile strain. The bar cast in the permanent mold and not annealed stood 15.36 tons per square inch tensile strain, an increased strength, it will be noted, of 50 per cent over the sand-cast specimen. The bar cast in a permanent mold and annealed stood 15.6 tons per square inch, being slightly stronger than the unannealed bar. Under the Brinell hardness test, the sand-cast bar gave an average hardness of 175, the bar cast in the permanent mold and not annealed gave a hardness of 269, and the bar cast in the permanent mold and annealed gave an average hardness of 193. This test was very important indeed, as it indicates the wearing qualities of the metal.

It is readily noted that the metal cast in permanent molds, whether annealed or unannealed, is considerably harder than that cast in sand molds, and therefore had far better wearing properties. It was interesting to note, however, that although the metal cast in permanent molds is considerably harder than that cast in sand molds, it is much more easily machined. This, no doubt, is due to the fact that the combined carbon was more evenly distributed in metal cast in permanent molds. A cutting speed of 200 feet per minute was possible with this metal. Keep's test gave a shrinkage on a 12-inch bar, ½-inch square, of 0.138-inch, and a chill 1/16-inch deep, showing that the metal was such as could be used for small parts of machine tools. This test, however, proved that the mixture is not altogether suitable for casting in permanent molds, as it is most important for this purpose that a mixture which is practically non-chilling be used. But at the time of the test it was very difficult to obtain pig iron which would give a non-chilling mixture.

Chemical Constituents

The chemical analysis of the sand-cast bar is as follows: Total carbon, 3.313 per cent; combined carbon, 0.218 per cent; graphitic carbon, 3.095 per cent; silicon, 2.868 per cent; manganese, 0.506 per cent; sulphur, 0.057 per cent; phosphorus, 0.990 per cent.

In the bars cast in permanent molds and not annealed it was found that the only important change which had taken place chemically was that the combined carbon had increased from 0.218 per cent to 0.709 per cent, and that the graphite carbon had decreased from 3.095 per cent to 2.645 per cent. This, of course, is always to be expected in castings made in permanent molds and is due chiefly to the increased rate of cooling, which to some extent, prevents the carbon from separating out. In the annealed bar, however, a considerable change had taken place, the combined carbon

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This paper was presented by the author, J. J. Howell, at the Dec. 9, 1916, meeting of the Birmingham branch of the British Foundrymen's Association.

being reduced to as low as 0.013 per cent while the graphitic carbon was increased to 3.300 per cent. This, of course, is accounted for by the annealing of this set of bars. But in this connection, a very important thing should be noted. The graphitic carbon in the annealed bar was exceedingly high and the combined carbon very low. In a sand-cast iron this would certainly give a very coarse fracture and a very weak iron, whereas the annealed bars cast in permanent molds were the strongest of the three sets and had the finest fracture. This is due to the graphitic carbon in iron cast in permanent molds being in an entirely different form from that in which it was found in iron cast in sand molds. Instead of being in large planes, it took the form of small particles very evenly distributed and perhaps it would be more correctly described as amorphous carbon.

With regard to the use of chills and permanent molds it must be distinctly understood that there is a great difference between the use of a densener and the use of a permanent mold. The use of chills locally simply accelerates and equalizes the cooling between a thick and a thin part of a casting, preventing porous patches and at the same time densifying the metal at this particular point. With a permanent mold, the advantage of the chill is received so far as the accelerated cooling of the metal is concerned. But the most important function of the permanent mold is that by its use an enormous amount of compression is put on the plastic casting, due to the expansion of the casting at its recalescent point. This expansion, of course, is turned into a compressive force by the use of the permanent molds.

It is not feasible to make all sorts of castings in permanent molds. A great deal, of course, depended on the shape of the casting required. But there are a large number of castings used which are difficult to cast satisfactorily in sand molds. Some of these could be made in permanent molds without any sign of unsoundness.

The experiments seem to indicate very clearly that not only should chills be used to equalize the cooling strains between thick and thin parts of castings, but wherever possible permanent iron molds should be used for the production of castings which are required to be exceptionally strong and dense.

According to statistics and estimates received by the United States Geological Survey, the output of blister and Lake copper from domestic ores in 1916 was 1,928,000,000 pounds, against 1,388,000,000 pounds in 1915 and 1,224,000,000 pounds in 1913. At an average of about 27 cents a pound, the output for 1916 was valued at $520,000,000, compared with $242,900,000 for 1915 and $189,790,000 in 1913.

Bethlehem Makes Large Iron Mold for Guns

What is claimed to be the largest octagonal, corrugated ingot mold ever made in this country was cast recently in the steel foundry of the Bethlehem Steel Co., South Bethlehem, Pa. The mold is 15 feet 7 inches in height and has a mean diameter of 91½ inches. At the thinnest section, or point of corrugation, the thickness of the metal is 15 inches, while the thickness of the heaviest section is 20¾ inches. Owing to the necessity of pouring this casting very quickly, it was made in the steel foundry rather than in the iron foundry. After finishing the mold, which required four weeks to prepare, standard bessemer iron, melted in three open hearth furnaces, was poured into ladles which were suspended over the mold simultaneously, and a continuous runner from these ladles was constructed, so that the iron was thoroughly mixed before entering the mold. The metal originally charged into the furnaces amounted to 340,000 pounds and after the mold had been filled, an additional 10,000 pounds was brought from the iron foundry, located three-quarters of a mile away, to pour into the sinkhead to take up the shrinkage. The added metal was filled in about a ton at a time for three hours, when the shrinkage stopped; the metal, however, remained liquid five hours after the mold was poured. The mold was left covered for some time and after shaking-out it was lifted from the pit by two large 100-ton cranes. The mold is to be used in making the tubes and jackets for large-sized guns. Before the mold can be used, large steel bands, 8 x 12 inches, must be shrunk around each end of the casting.

Chilled Castings from a Cupola Running Gray Iron

By W. J. Keep

Question:—We are trying to melt gray iron in a cupola, which by the use of an iron chill in certain parts of the mold will give a chilled surface approximately 1/16 inch deep and at the same time we desire to have the metal machinable in the unchilled sections. To obtain these results, we probably will have to run a mixture containing 1 per cent silicon or less and above 3 per cent carbon. We would like to know just what our mixture analysis should be. In making your recommendations, we would be glad to have you state the percentages of various grades of raw materials to be used and the complete analyses of the pig iron recommended. How can the foregoing mixture be obtained without the use of car wheel scrap?

Answer:—You will not have to use a special iron to get a 1/16-inch chill, neither will you have to employ a very low silicon iron. You can readily purchase a coke iron with a chilling tendency. However, you failed to state from what portion of your heat you wish to tap the chilling iron. If you desire to produce only a small number of such castings with the remainder soft, charge 10 per cent of steel punchings in the cupola with one of the charges, or you can place in the ladle, before catching the iron, a quantity of light steel castings which will be melted by the iron running over it. A piece of sulphur placed in the ladle will impart a chill to that ladle of iron. Also, you can accomplish this same result by keeping the silicon low in as many charges as are required to produce the castings that are to be chilled. To produce a chill 1/16 inch thick, you will not require very low silicon when using chillers in the mold. The silicon is all that you will have to regulate. From the company furnishing you pig iron you can obtain analyses of each carload and with these analyses and that of the iron which you have, you can readily calculate the silicon requirements. For regular chilled castings, such as the rims of wheels, some brands of pig iron naturally produce a chill, regardless of what the silicon may be and most brands of charcoal iron will accomplish this. Ordinary car wheel scrap also is good for this purpose. For making car wheels, a large number of manufacturers use steel scrap, which helps to impart the necessary chill.

The Steel Treating Research Club, of Detroit, has acknowledged the receipt of an unsolicited contribution of $100 from Sir Robert Hadfield, of London. He has also prepared a discussion of Harvard J. Stagg Jr.'s paper on impact tests recently presented at a meeting of the Steel Treating Research Club. A paper on "Advances in Metallurgy of Iron and Steel", now being prepared by Sir Robert Hadfield, will be available in a few months.

William N. Gartside, president of the Diamond Clamp & Flask Co., Richmond, Ind., died on Sunday, March 4.

Modern Methods of Melting Non-Ferrous Metals

Results of Recent Experience Discussed in Series of Papers
Presented at March Meeting of British Institute of Metals

Summary of Papers Presented at Institute of Metals

A symposium of papers on the melting of non-ferrous metals was presented at the annual meeting of the Institute of Metals, held at London, Eng., March 21 and 22. The developments that have taken place as the result of recent experience, were discussed from the viewpoint of the acceleration of output and efficiency of operation. "Metal Melting as Practiced at the Royal Mint," was the subject of a paper presented by W. J. Hocking, London, which discussed the melting and casting into bars for coinage, of standard gold, silver, bronze and cupro-nickel. These castings are of comparatively small dimensions and are in the form of thin, rectangular strips, about 2 feet long, varying in width and thickness. Until 1910, coke furnaces were used, but as the result of a series of experiments, furnaces fired by low-pressure gas and air are employed.

G. B. Brook, of Sheffield, discussed "Coal Gas as a Fuel for the Melting of Non-Ferrous Alloys." The results of experiments made at the University of Sheffield, which showed the material advantages of gas over other fuels for melting non-ferrous alloys, were presented. H. M. Thornton and H. Hartley, London, read an interesting paper entitled, "The Melting of Brass and Copper in a Crucible Furnace With Coal Gas Fuel." It was pointed out that the life of pots obtainable in gas-fired furnaces is greater than in coke-fired furnaces, and the time required for the melt is less than in furnaces using solid fuel. Also, marked fuel savings result when the furnace is designed so that the metal is preheated before admission to the blast furnace.

Other papers presented, include the following: "Ideals and Limitations in the Melting of Non-Ferrous Metals," by Carl Hering, Philadelphia; "Metal Melting in a Simple Crude Oil Furnace," by H. S. Primrose, Ipswich, Eng.; "Annealing Nickel Silver," by F. C. Thompson, Sheffield; "The General Properties of Stampings and Chill Castings in Brass of Approximately 60-40 Composition," by W. Ellis, London; "Aluminum Production by Electrolysis," by R. Selegman, London, and "Surface Tension and Cohesion in Metals and Alloys," by Sydney W. Smith, London. Summaries of a number of the papers which were presented at the meeting appear on the following pages.

Melting Brass in a Gas-Fired Cupola Furnace

By H M Thornton and H Hartley

THE marked success achieved by furnaces employing coal gas as a fuel, in the heat treatment of metals such as steel, is proving of material assistance in the introduction of gas-fired, metal melting crucible furnaces. It is proposed, in this paper, to deal only with a furnace of the type intended for melting the metals of higher melting point, from brass upwards.

In working with coal gas the fact must not be overlooked that in terms of B. T. U. available the fuel is costing from four to five times as much as coke, assuming the gas supply to give 500 B. T. U. per cubic feet net at a cost of 2s per 1,000 cubic feet, and even with water gas the fuel is considerably more costly per B. T. U. than the coke which it is intended to replace. Starting with this disadvantage the furnace manufacturer has either to obtain a markedly greater thermal efficiency out of his appliance, or to effect economies in other directions.

When asked to quote fuel consumptions, the furnace manufacturer will not be able to do so unless the melter can provide some fairly precise information as to the pouring temperature required. In the authors' work with brass and copper the pouring temperature has ranged about 100 to 150 degrees Cent. above the liquidus. In this connection it is of interest to recall the work of Mr. Lohr, in which the conclusion is drawn, after an examination of the copper-zinc alloys, that the best pouring temperature is between 100 and 200 degrees Cent. above the liquidus, a higher pouring temperature always producing an oxidized casting. With reference to brass melting, overheating is not advisable, as there is always the danger that it will lead to honeycombing if the metal is cooled before pouring.

Brass Melting

Starting from cold the additional fuel needed acts as a handicap in the endeavor to obtain low average consumptions, the overall effect of which is decreased by increasing the number of melts carried out successively. For the fourth and subsequent melts it is found generally that the gas consumption per pound of metal melted remains practically constant. In the last melt of the day a small saving is effected, owing to the fact that there is no excess of brass in the metal preheating chamber, and in consequence the degree of preheating of both the metal and air increases.

In the accompanying table are given results of a typical run, limited to six melts to avoid repetition, and added are the average consumptions on the basis of 12, 15 and 20 melts.

	Gross consumption per lb. metal melted, cu. ft.	B. T. U. per lb. metal melted.
Average for 6 melts...	2.25	1,203
Average for 12 melts...	1.92	1,031
Average for 15 melts...	1.86	996
Average for 20 melts...	1.79	962

Analyses of two brasses remelted several times (*a*) with a sawdust covering, (*b*) with common salt as a flux, indicate that the loss of volatile constituents is much the same even when the metal is rendered very hot. There is a certain amount of inconvenience attached to working with a salt covering, owing to the acid fumes produced. On the other hand, salt is stated to be useful in small quantities, admixed with charcoal to prevent absorption of sulphur by molten copper and its alloys, and to lessen the retention of viscid metal by the dross. The fluxes used more generally are calcium fluoride, glass and potassium hydrogen sulphate. The authors incline to the view that the most satisfactory results are obtainable by the use of a charcoal or similar covering, together with a small amount of flux. In an inert atmosphere the rate of loss of zinc from a given brass will depend on the temperature and the speed of flow of the gases over the metal. During melting the process may be accelerated owing to the oxidation of the zinc vapor and consequent reduction of the partial pressure of the metallic vapor. The effect of this latter factor is decreased to some extent if the combustion of the gases is not completed in the pot chamber, and still further if a covering of charcoal is employed. In the final heating stage, after the metal is molten and when the greatest loss occurs, a crucible lid previously heated in the metal preheating chamber can be used to cover the pot and decrease the loss.

Assuming that it requires in the respective furnaces 3.0 cubic feet of coal gas, or 0.5 pound of coke per pound of metal melted; then if the gas is burnt completely to CO_2 in the pot chamber, the volume of products (calculated at 0 degree Cent. and 760 mm.) will be about 14 cubic feet, whereas with the coke if it burns to CO_2 there would be about 77 cubic feet of products, and if only CO were formed, about 45 cubic feet. From three to five times the volumes of products flowing through the gas-fired furnace pass through the coke furnace.

Zinc Losses

The authors have investigated the question of zinc losses in connection with gas-fired furnaces. In making up a red brass containing a little tin in four 50-pound lots, they found the average zinc loss not to exceed 3 per cent. With regard to the zinc loss on remelting yellow brass, the following tests were made: Two 70-pound lots of works scrap brass A and B were melted and cast into chills. sample ingots being retained for analyses. Batch A was then remelted with a covering of sawdust only, cast into ingots, a test ingot withdrawn, and the remainder returned to the crucible, remelted, and a further sample taken. This treatment was repeated, five remelts in all being made. In the last melt, after the pourers had approved the metal to be sufficiently hot for casting purposes, the crucible was left in the furnace for another half-hour, the temperature of the metal being raised steadily during the whole of this period. The second batch of metal B was treated in a similar manner, except that in this case a covering of common salt was employed, and no provision of charcoal made for the prevention of oxidation. In neither case was a crucible lid used. The test ingots weighed about 3 pounds each. As a result of these tests it was found that with a low pouring temperature, that is, 1,000 degrees Cent., the loss of zinc need not exceed 1½ per cent of the zinc originally present. With a red brass poured at 1,090 degrees Cent., the loss was somewhat higher, while when the temperature of a yellow brass was raised to 1,180 degrees Cent., the zinc loss rose to about 6 per cent.

Melting tests with copper proved how important it was to load up the pot as much as possible if the most economical melting is desired. Materially better results were obtained when the charge was mixed scrap and ingots than when only sheet scrap was handled.

Thermal Efficiency

From the results given for brass, combined with those obtained with copper, it is possible to arrive at an estimate of the additional gas consumption necessary to heat the brass to a considerably higher temperature. If it be assumed that the specific heat of brass is the same as that of copper (at ordinary temperatures this is very nearly so), and that the heat allowance to be made for the liquefaction of the brass is 152 B. T. U. per kilogram; then the steady state efficiency during the fifth brass melt (metal poured at 990 degrees Cent.) will be 30 per cent. Over-all efficiency for six brass melts (990 degrees Cent.) will be 21.3 per cent. To get the brass to 1,090 degrees Cent. would require about 1,456 B. T. U. per pound. With an increased number of melts the actual extra gas used on the basis of the average for the day's work decreases, but still remains about 20 per cent more than that required for 990 degrees Cent. As regards copper, with 560 B. T. U. gas the six melts were made at an average consumption of 2.25 cubic feet per pound gross, equal to 1,200 B. T. U. per pound of metal melted, from which it would appear that, roughly, the thermal efficiency of the gas furnace is about five times that of many coke furnaces, the latter converting approximately 4 per cent of the available energy into useful work.

The results were obtained by the authors in a gas-fired furnace, with an arrangement for pre-heating the metal prior to charging and for pre-heating the air supply before it was admitted to the blast burner. A simple calculation shows that pre-heating can effect a considerable saving of fuel. In actual practice with brass the following results were obtained, pouring at about 1,000 degrees Cent.:

No. of melts made consec....	4	6
	Gas consumption per lb. of metal melted.	
No preheating (*a*)...........	3.10	2.91
Brass preheated (*b*).........	2.72	2.48
Brass and air preheated (*c*)..	2.42	2.17

The actual consumption in cubic foot per pound for the fourth melts were: (*a*) 2.52; (*b*) 1.99; (*c*) 1.66. Thus it is evident that for brass melting the most suitable type of furnace to be employed will depend upon the number of melts required daily, as when only a few melts are required the additional capital cost involved in the introduction of the preheating device may not be compensated for adequately by the gas saved.

A well-made graphite crucible is capable of withstanding very sudden temperature changes to an almost surprising extent. According to Mr. Downs, in actual commercial use for melting purposes a crucible has been known to stand from 80 to 100 charges in melting copper or a similar metal. Many melters, however, only claim about 30 melts per pot. In a gas-fired furnace the abrasive action of the solid fuel is eliminated, the direction of flow of the gas stream is under better control, the sulphur content of the fuel is very small (about 30 grains per 100 cubic feet), there is no fire to poke, and clinkers do not have to be removed from the outside of the pot, so that it is not surprising that long pot lives can be obtained, especially in the absence of fluxes, or with a flux which does not attack the crucible walls viciously.

The average time for the actual melting operation for 12 melts of 68 pounds each, is 30 minutes, and for 15 melts, 37 minutes, making no allowance for the time required to pour. Under similar conditions 55 minutes would probably represent an average for many coke-fired furnaces. It should be noted, however, that the authors' results for gas consumptions have all been obtained in the works of the Richmond Gas Stove & Meter Co., by members of their staff, and are not to be regarded as representing *works practice*, as ordinarily understood.

Description of Furnace

The metal melting referred to has all been carried out in a Richmond 70-pound crucible furnace of the pre-heating type. The gas and air mixture is admitted through a suitable blast burner and the lower portion of the combustion chamber, and is burnt in the annulus between the crucible and the furnace wall. The gases, after traveling around the pot, are directed through the metal pre-heating chamber, and then pass on

THE FOUNDRY DATA SHEET, MAY, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

MELTING POINTS OF THE CHEMICAL ELEMENTS

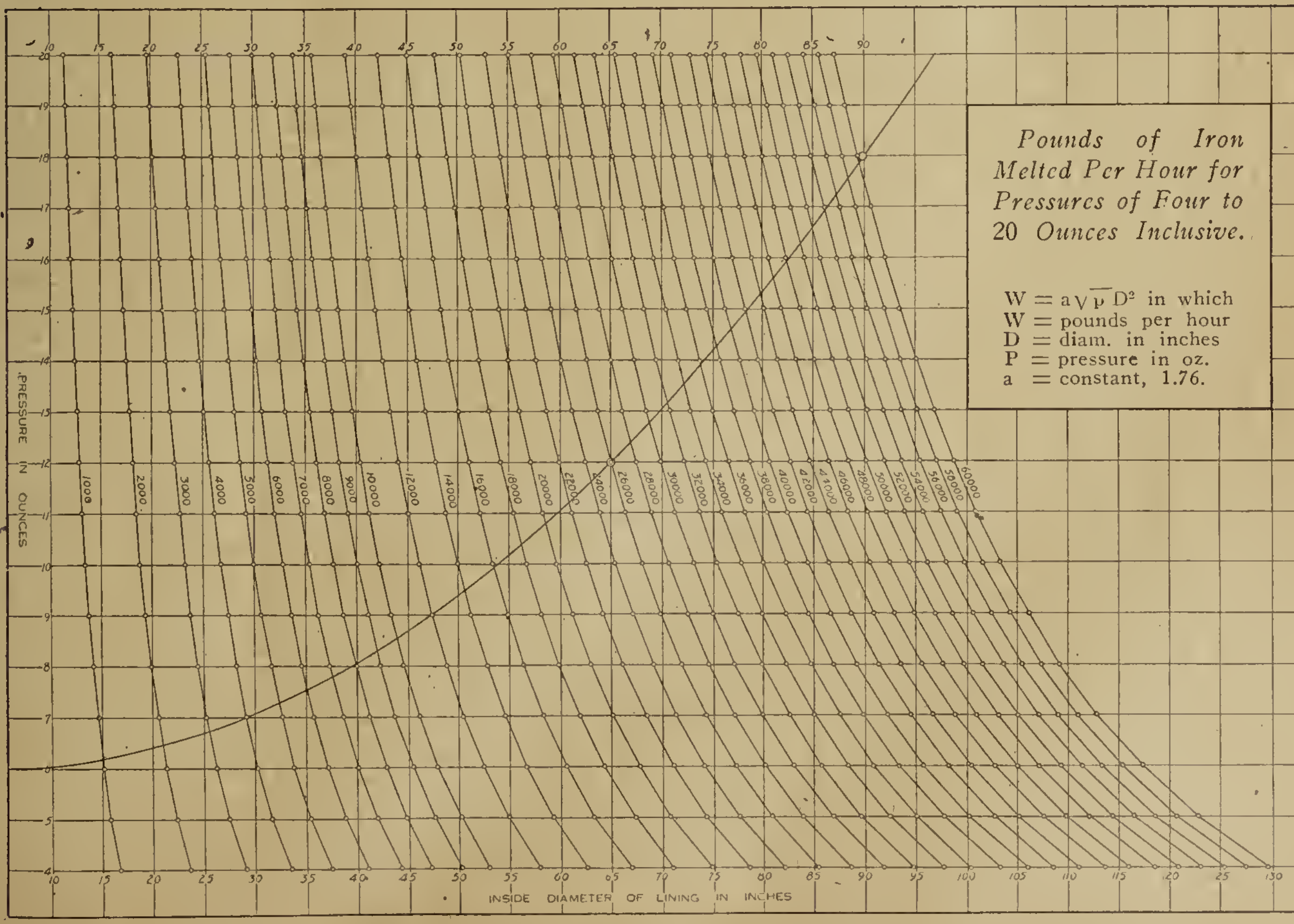
From Circular No. 35, United States Bureau of Standards, 1915

Element.	Cent.	Fahr.	Element.	Cent.	Fahr.	Element.	Cent.	Fahr.
Helium	—271	—456	CADMIUM	320.9	609.6	Cobalt	1,480	2,696
Hydrogen	—259	—434	LEAD	327.4	621.3	Yttrium	1,490	2,714
Neon	—253?	—423	ZINC	419.4	786.9	Chromium	1,520	2,768
Fluorine	—223	—369	Tellurium	452	846	IRON	1,530	2,786
Oxygen	—218	—360	ANTIMONY	630.0	1,166	PALLADIUM	1,549	2,820
Nitrogen	—210	—346	Cerium	640	1,184	Zirconium	1,700?	3,090
Argon	—188	—306	Magnesium	651	1,204	Columbium (Niobium)	1,700?	3,090
Krypton	—169	—272	ALUMINUM	658.7	1,217.7	Thorium	} 1,700 { Pt.	} 3,090 { Pt.
Xenon	—140	—220	Radium	700	1,292	Vanadium	1,720	3,128
Chlorine	—101.5	—150.7	Calcium	810	1,490	PLATINUM	1,755	3,191
MERCURY	— 38.9	— 38.0	Lanthanum	810?	1,490	Ytterbium	?	.....
Bromine	— 7.3	+ 18.9	Strontium	} Ca { Ba?	.....	Titanium	1,800	3,272
Caesium	+ 26	79	Neodymium	840?	1,544	Uranium	{ 1,850	{ 3,362
Gallium	30	86	Arsenic	850?	1,562	Rhodium	1,950	3,542
Rubidium	38	100	Barium	850	1,562	Boron	2,200–2,500?	4,000–4,500
Phosphorus	44	111.2	Praseodymium	940?	1,724	Iridium	2,350?	4,262
Potassium	62.3	144	Germanium	958	1,756	Ruthenium	2,450?	4,442
Sodium	97.5	207.5	SILVER	960.5	1,761	Molybdenum	2,500?	4,500
Iodine	113.5	236.3	GOLD	1,063.0	1,945.5	Osmium	2,700?	4,900
Sulphur	S_I 112.8 S_{II} 119.2 S_{III} 106.8	235.0 246.6 224.2	COPPER	1,083.0	1,981.5	Tantalum	2,850	5,160
Indium	155	311	Manganese	1,260	2,300	TUNGSTEN	3,000	5,430
Lithium	186	367	Samarium	1,300–1,400	2,370—2,550	Carbon	} 3,600 for p = 1At.	} 6,500 for p = 1At.
Selenium	217–220	422–428	Beryllium (Glucinum)	1,350?	2,462			
TIN	231.9	449.4	Scandium	?	.....			
Bismuth	271	520	Silicon	1,420	2,588			
Thallium	302	576	NICKEL	1,452	2,646			

THE FOUNDRY, DATA SHEET NO. 233, MAY, 1917.

AVERAGE OUTPUT OF CUPOLAS

By F. A. Coleman



Pounds of Iron Melted Per Hour for Pressures of Four to 20 Ounces Inclusive.

$W = a\sqrt{p}\,D^2$ in which
W = pounds per hour
D = diam. in inches
P = pressure in oz.
a = constant, 1.76.

THE FOUNDRY, DATA SHEET NO. 234, MAY, 1917.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

to the air pipes, and finally to the flue. This arrangement enables a high degree of preheat of the metal to be obtained. The top of the metal chamber is on a level with the top of the pot chamber, and is closed by a pair of lids. With this construction the operator does not have to lift his metal above the foundry floor level, and the transference of preheated material to the crucible is accomplished with ease. The lower portion of the wall of the combustion chamber is constructed of suitably shaped blocks of a specially refractory nature to enable greater resistance to be offered to the combined action of high temperatures and split metal. The bottom of the chamber can be removed.

Melting Practice at the Royal Mint

By W J Hocking

STANDARD gold, silver, bronze and cupro-nickel are melted at the mint and cast into bars for coinage. The castings are of comparatively small dimensions, and are in the form of thin, rectangular strips about 2 feet long, varying in width and thickness.

In melting precious metals for coinage work, the correct proportions of the gold-copper and silver-copper alloys must be maintained within the restricted limits of variation prescribed by law. For this reason the volume of the charge is limited to one which can be conveniently stirred and manipulated with a view to the production of bars uniform in composition. For gold the weight of the charge is 2,800 ounces, for silver about 6,000 ounces, and for bronze and cupro-nickel about 400 pounds.

Coke furnaces were in use until 1910. The melting department was then enlarged and rebuilt, and, as the result of a series of experiments, furnaces, fired by low-pressure gas and air, were introduced. Urgent demands for coinage arose, and during the rebuilding operations an improved gas-melting plant was installed, with a floor space of 860 square feet only. In the course of a year and nine months 874 tons of standard gold were melted. As a test of the efficiency of the four experimental furnaces in use, a continuous run of melting was maintained for 27¾ hours. The total amount of gold melted was 257,052 ounces, or 7.87 tons. There were 102 pourings, and the consumption of gas was 32,000 cubic feet. The furnaces were in a condition to resume work on the following day as usual.

New Furnaces for Melting Silver and Bronze

The larger of the two new rooms for melting operations was completed before the close of the probationary period in the blacksmith shop and work was commenced therein in January, 1911. Sixteen furnaces are constructed in line near the center of the room, divided in two batteries, one of 10 and one of six. The furnaces are built of fire brick, each well being 19 inches in diameter and 32 inches deep. The wells are lined with circular bricks, 3 inches thick, jointed with a refractory material composed of carborundum, firesand and silicate of soda, which is also used as a backing for the bricks. The face of the bricks forming the interior of the wells is treated with a wash made up of the same materials. The whole mass of brickwork is braced together by a framework of iron bars to resist expansion, but is not enclosed with iron casing. For convenience the furnaces stand 27 inches above the floor level. The tops are covered with cast iron plates 1 inch thick, bedded upon a ½-inch layer of asbestos cement. The plates are fitted loosely in sections to admit of expansion, and are shaped to allow a lip of brickwork around each furnace hole, 4½ inches broad. This ring of brickwork is made to rise slightly above the level of the iron tops, and serves to prevent the fusion of the iron coverings. The tops were at first carried to the edge of the furnace holes, and the molten iron scored the face of the furnace linings, necessitating frequent renewals. A circular fire brick, 27 inches in diameter and 3 inches thick, is used to close the mouth of the furnace hole during melting. This cover is surrounded by two semicircular iron bands, ¾-inch thick, bolted together to form a frame. The cover, which weighs 150 pounds, is lifted and wheeled into any desired position on the furnace top by means of a specially-designed truck.

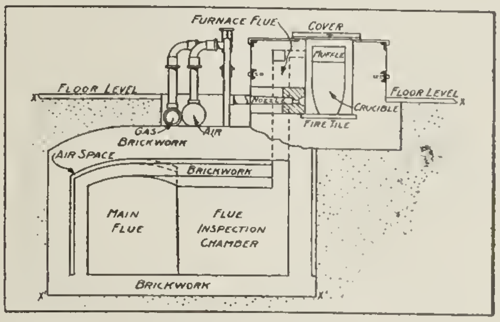


FIG. 1—SECTIONAL ELEVATION OF FURNACE

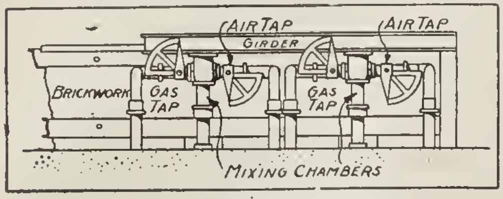


FIG. 2—BACK ELEVATION OF TWO FURNACES

An electrically-driven overhead traveling crane of 500 pounds capacity hoists the crucible of molten metal from the furnace, and transports it to one of two pouring frames. The movements of the crane are directed by means of switches situated at two platforms. When in position for pouring, the crucible is gradually tilted by worm gearing connected with the frame through a quadrant, and the contents poured into iron molds. The molds are set up in batches of about 40 in wheeled carriages which travel on a permanent track laid lengthwise of the room with a turntable and side-track at one end. During the process of pouring, the forward motion of the carriage on the rails as the molds become full, as well as the upward movement of the crucible, is secured by rack and pinion gearing attached to the frame, the motions being actuated by separate wheels, controlled by two workmen.

Fuel Supply and Combustion

Experience gained with the use of gas fuel in the temporary gold-melting house pointed to the desirability of securing a liberal supply of gas at a constant pressure. The supply of gas under these conditions was undertaken by the gas company. In the large house the gas is delivered at the furnaces at a steady pressure of 3 inches of water at the furnace. As the total consumption of the 16 large furnaces is about 15,000 cubic feet per hour, the provision for delivery is well in excess of the requirements. An ample reserve is considered essential to uniformity in results.

Three rotary blowers of the Reichhelm type are used to supply air for the burning mixture. Each blower is capable of delivering 36,000 cubic feet of free air per hour at 2½ pounds pressure. All the pressure blowers are motor-driven, and two are coupled to feed the larger battery of 10 furnaces. The maximum horsepower required to supply air under pressure for the whole of the furnaces in the large room is 45. The air and gas are supplied by pipes laid below the ground level in a trench running parallel with the back of the furnaces. The sizes of these pipes are sufficiently large to admit of one or more furnaces being thrown in or out of action without disturbing the steadiness of the supplies to the remainder; that for air is 9 inches, and that for gas is 5 inches to the larger battery and 4 inches in diameter to the smaller. Connecting pipes from each of the two services are attached to a horizontal girder for support, and conduct the air and gas into a Brayshaw mixer. The pressures are 3 inches for gas and 2½ pounds for air. Check gages are in use to see whether these pressures are obtained at the furnaces.

Furnace Construction

Fig. 1 is a sectional elevation of the furnace, showing the crucible, muffle and cover, the gas and air pipes with nozzle and burner brick in position, and the main flue with its connections. Fig. 2 is a back elevation, showing the gas and air pipes with quadrant taps, and the girder support.

Fig. 3 shows a plan of two furnaces without their covers, each containing a crucible. One shows the top view with flue, and the other the bottom with nozzle and burner block. The admission pipes to the mixing chamber are fitted with valves, the levers of which move over a graduated quadrant. With well-constructed taps of this description the supply of gas and air can be regulated with precision. In the course of a heat these supplies require adjustment as the temperature rises in the furnace. From the mixing chamber the gaseous fuel passes through a right-angle elbow pipe, 2½ inches in diameter, to the furnace. To adjust the length of flame to the capacity of the furnace and secure greater melting efficiency, the internal diameter of this pipe was reduced at its extremity to 1¾ inches. The method of inserting the nozzle of the burner into the wall of the furnace, illustrated in Fig. 4, is the one yielding most satisfactory results. An 8-inch end-piece, screwed in position and having a diminished bore, forms the nozzle, which is increased to 4 inches in outer diameter at its extremity. It is easily detached and renewed in the event of corrosion or partial fusion.

The ignition hole of the furnace consists of a perforated fire brick of special shape as shown in the sectional drawing given in Fig. 4. A circular recess, 4 inches in diameter, at the back of the block, which is 9⅛ inches square on the face, receives the iron nozzle which fits the recess closely, and is surrounded by asbestos packing well rammed in. The comparatively large block of fire brick serves to keep the nozzle relatively cool. At the bottleneck the inlet is 1¾ inches in diameter, corresponding with the bore of the burner. The passage then opens out at an angle of 30 degrees into the well of the furnace. The burner block is set to one side of the horizontal axis of the furnace well into the brickwork in a position to induce the flame to pass between the crucible and the side of the furnace without impinging upon either. The crucible is placed centrally in the furnace upon a graphite stand, 10 inches in diameter and 2¼ inches thick. A plumbago muffle or collar, 8 inches deep, rests on the crucible to increase its initial capacity, but no cover is used for the charge during melting in the case of silver and the baser metals. About 3 inches clear space is allowed around the crucible at its greatest diameter to admit of the lowering of the tongs which lift it from the furnace for pouring. When the furnace is closed the top of the muffle is within 2 inches of the cover.

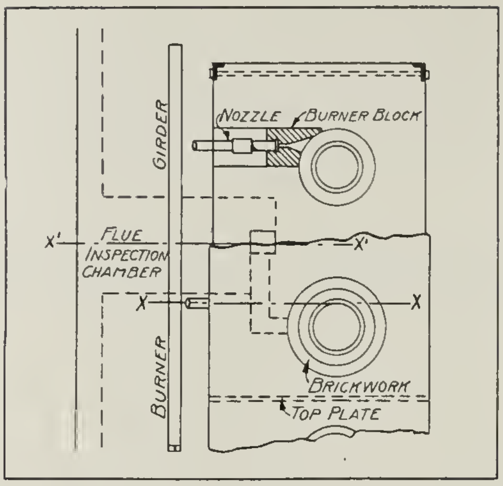


FIG. 3—PLAN OF TWO FURNACES

The gas flame on leaving the ignition hole travels round the crucible in an upward double spiral. The best results in economy and efficiency are obtained when combustion is complete in the furnace itself, no flame being emitted under the furnace cover nor carried into the flue aperture. To reduce the length of the flame, which grows as the temperature in the furnace rises during the progress of the melt, the supply of gas and air is reduced. The flue aperture is 4 x 2 inches in sectional area, with its axis 5 inches below the iron covering plates, and opens into a horizontal duct leading from the furnace to a vertical shaft, 6 inches square, which serves two furnaces, and is connected with the main flue below the floor level. The main flue before entering the chimney shaft passes through a condensing chamber provided with baffles to intercept any solid matter carried off by the flue gases.

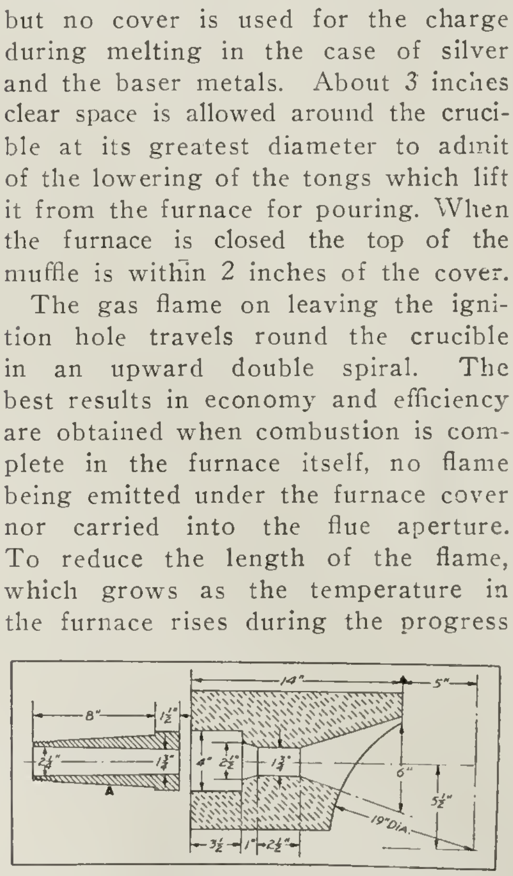


FIG. 4—FIRE BRICK BURNER BLOCK; THE GAS BURNER NOZZLE IS SHOWN AT *A*

For the prevention of accidents in the use of the large volumes of gas and air delivered to the furnaces, a recognized system of workshop procedure was necessary. The following routine works satisfactorily. All the air valves are opened, and the blower is then started to deliver air to the furnaces. Then, dealing with each furnace successively, the air valve is closed, the gas valve opened, the gas ignited, and the air valve reopened to its utmost capacity. So soon as the whole series of furnaces is alight, the gas and air taps are adjusted to produce the proper burning mixture in each case. In shutting off a single furnace the gas valve is first closed and then the air. When dealing with the whole battery, the gas valves are closed on all the furnaces, the pressure blower stopped, and the quadrant taps turned off. Should the blower stop unexpectedly through a breakdown all gas and air taps are closed immediately. In view of this emergency the air pipes are, in some cases, provided with nonreturn valves which are automatically brought into action as soon as the pressure ceases. Experiments are in progress to devise a simple and effective form of safety gear for such a contingency.

Caring for Linings

The furnace linings receive close attention, which is repaid by a lengthened life. The surfaces are kept free from excrescences which would obstruct the free passage of the flame. Accumulations of slag at the bottom of the furnace are cleaned out at frequent intervals. Faults in the brickwork are patched immediately. As a general result the entire lining of a furnace is renewed two or three times a year.

Provision is made for the ventilation of the melting house by three Blackman fans, placed one at each end and one at the side, near the roof. These can be used either for supply or exhaust, as required. If two of the fans are drawing from the room, and one is discharging into it, the whole volume of air is changed every ve minutes, independently of the oors, windows and skylight.

Comparison of Costs of Melting

Records are kept in the department f the results of melting with gaseous uel for comparison with similar reults obtained with coke. These reults are available for a period of ve complete years, both for gas nd coke. During the five years, 911-16, nearly 10,000 tons of metal vere melted and cast into bars for oinage with a total consumption of 21,000,000 cubic feet of gas. A comparison of the records for the two periods shows an economy in favor of gaseous fuel under each of the folowing heads: (1) Rate of output, (2) cost of fuel, (3) cost of graphite goods, (4) cost of labor.

(1) *Rate of Output.*—Except for gold, crucibles of the same capacity as formerly were used, but the time required for the heats was shortened considerably. The rate of output per furnace in the working day was correspondingly increased, and this increase was especially noticeable in the case of bronze, 157.7 per cent, and cupro-nickel, 161.1 per cent.

(2) *Cost of Fuel.*—The respective costs of coke and gas vary considerably in different localities. They are also liable to vary in the same locality during a given period. During 1905-9 the price of best foundry coke delivered broken for use at the Mint fluctuated from from 35s to 42s 4d per ton; while during 1911-16 the discount price of gas per 1,000 cubic feet varied only very slightly from 21d, except during nine months of 1915-16, when t was 18.2d. Although the price of gas advanced 12½ per cent during the last five years, the net cost to the Mint remained practically stationary owing to the sliding scale of discounts allowed by the gas company. On the total expenditure for fuel for the two periods of five years a cash saving of 3½ per cent on the amount consumed per ton melted is shown for 1911-16. The amounts melted and the fuel consumed for the two periods are shown side by side:

	1905-9.	1911-16.
Gross amount of metal melted....	4,833 tons	9,899 tons
Total consumption of fuel	2,677 tons	121 million cu. ft.
Consumption of fuel per ton melted	11 cwt.	12,220 cu. ft.
Cost of fuel per tons of metal melted	21.3s.	20.58s.

(3) *Cost of Graphite Goods.*—The crucibles used for both the coke-fired and the gas-fired furnaces were of the Morgan salamander brand, the mixture being modified in the latter case to suit the firing. A considerable extension of life was found when they were used with gaseous fuel.

The total inclusive costs for the two periods are placed side by side, and show that the rate per ton melted has been reduced by about one-third:

	1905-9. (Coke Fuel)	1911-16. (Gas Fuel)
Weight of metal melted.	4,833 tons	9,899 tons
Total cost of crucibles, etc	£9,625	£13,295
Cost of crucibles per ton melted............	39.8s.	26.8s.
Rate of reduction in costs		32.6 per cent.

The figures for costs shown cover in each case the purchase of muffles, covers, stands and stirrers as well as crucibles.

(4) *Cost of Labor.*—Coke fuel necessitates considerable handling; gaseous fuel is delivered at the furnace without manual labor. During 1905-9, the average annual consumption of coke was 535 tons. Two men were employed in each melting house to transfer the coke from the store to the furnaces as required and to remove the ashes and clinker. This labor, as well as that of periodically feeding the furnaces, was abolished with the introduction of gas fuel.

Ideals in Melting Metals

By Carl Hering

THE object of the paper is to summarize the principles underlying the best possible conditions for the melting of metals, chiefly from the standpoint of the thermal engineer, for the purpose of showing the directions in which to look for possible progress toward these ideals, and for pointing out the limitations imposed both by theory and practice, showing how they might be more closely approached in practice.

The possible directions of improvements are enumerated and discussed with the ultimate object of reducing the total cost of melting per pound of satisfactory castings. An intelligent combination of small economies may amount to an appreciable total. Economies should be properly compared; for instance, it is shown that the use of the more costly electric heat instead of cheap fuel heat may sometimes result in less total cost, notwithstanding an increased cost of the heat and of the plant.

The losses of heat are analyzed, and it is shown how some of them may be reduced. Heat insulation, over-insulation, reducing the time the metal is hot, the advantages of rapid heating and casting, superheating and how the thermal losses caused by it can be reduced, are discussed. The characteristic differences between combustion and electric heat and their effect on metal heating are pointed out. The causes of the loss of zinc during melting are briefly considered.

Gas as Fuel for Melting Alloys

By S B Brook

SOME years ago experiments were made in the University of Sheffield which went to show the material advantage possessed by gas over other fuels for the melting of non-ferrous alloys. The results were sufficiently promising to prompt the author to carry out a severe test and one of longer duration.

It was decided, therefore that such tests should be carried out on material which demands probably the highest temperature of any industrial non-ferrous alloy, namely, cupro-nickel; that the test should extend over not less than 10 full days of 10 hours each and commercial practice in the size of the ingot, etc., should be followed. It was the author's endeavor to provide melting data obtained from an experimental run on a sufficiently large scale to eliminate such misleading conclusions as are sometimes inseparable from the translation of laboratory experiments into works practice.

A gas-fired pit furnace of a modern type was placed at the author's disposal and it is the relative advantage of this fuel as compared with coke that forms the basis of the paper. The writer had hoped to embody data relative to an oil-fired pit furnace, but pressure of war work precluded this.

Summary of Tests

The following summary in form of question and answer sets out the objects of the test and the deductions to be drawn therefrom:

(1) Would ordinary coal gas give a temperature that was sufficiently high for this alloy?

(a) No difficulty at all was obtained in securing a temperature of 1,400 degrees Cent.

(2) What was the relation between the coke-fired furnace and the gas-

fired furnace from the following standpoints?

(a) *The Relative Cost of Melting.*—Average cost of melting with high grade metallurgical coke, 36/4 per ton; with gas at ordinary Sheffield rates, 31/9 per ton; and at the preferential rate allowed to users of gas for gas engines, 24/2 per ton.

(b) *Relative Speed of Melting.*—It was under this heading that the great advantage was shown by gas over coke. The same weight of metal can be melted in the gas furnace in 52 minutes which required 82 minutes in the coke-fired furnace. When this advantage is translated into commercial practice, the advantage is still more striking; for on two days during the test it was possible to obtain 12 heats in the 10-hour period, whereas the writer has only on very exceptional days been able to obtain seven heats from a coke-fired furnace per day.

(c and d) *The life of the crucibles and the wear and tear of lining and burner.*—The graphite crucibles of the same make have as long, if not a longer, life in properly controled gas-fired furnaces as in coke. The lining of the furnace and the burner suffered no depreciation of appreciable seriousness.

(e) *Metal Losses.*—Such loss was found to be below the average, and from the general stability ensured to the crucible mechanical loss ought to be far less than in the coke-fired type.

(f and g) *Labor and Capital Charges.*—The labor charges per ton of metal produced would be less in the gas-fired furnace from the fact that a larger number of furnaces can be controled by the same staff and the output of such a team of men would be higher in the case of gas-fired furnaces.

Quality of Product.—The cupro-nickel was tested at every stage and was found to be satisfactory. The ultimate test in the production of bullet sheaths, showed that the material was equal, if not superior in both quality and minimum failures, to any that had been produced in coke-fired furnaces.

The absence of ashes, the elimination of the wasteful process of slagging, the economy of fuel in ease of control, and the reduction of impurities introduced in the process of melting, are factors of considerable importance to the manufacturer and confirm the writer's findings that the claims of coal gas as a fuel for the melting of non-ferrous alloys rest on a very sound economic basis.

Melting in a Crude-Oil Furnace

By H S Primrose

IN MANY places where large outputs of brass are required it has not been possible to obtain sufficiently cheap gas or the necessary pressure. There the greatest use has been made of various forms of oil furnace, and the author describes a simple type which he has helped to evolve to do away with the difficulty of skilled labor.

The furnace may be so made as to take variously sized crucibles, and results are quoted of the working of these furnaces with 100 and 200-pound pots.

A full description of the construction and working of the furnaces is given, and recommendations are made as to the best method of regulating the amount of air required for the most complete combustion of the oil, supplied through either a high or a low pressure burner. The furnaces being placed on the floor level require no flues, and thus save trouble in cleaning.

Their first cost is not great and repairs are few and inexpensive. With the low pressure burner they are not so destructive on crucibles as the more cutting gas flame.

Some actual melting results of a battery of this type of furnace are quoted to show the amount of work they are capable of doing on a continuous run.

Electric Heating of Crucibles

By H C Greenwood and R S Hutton

THE authors have had occasion to note the great improvement in working qualities of nickel-silver alloys melted with gas over similar alloys melted with coke. Electric heating should show an even greater advantage. For non-ferrous alloys a construction of furnace suitable for using ordinary crucibles is especially desirable.

The electric furnace designed by the authors takes a 100-pound plumbago pot. The electric heating is independent of the crucible, the furnace being of the resistance type, the current passing through upright carbon rods situated near the inner face of the walls of the furnace; the heating thus is under perfect control.

Actual tests carried out with a charge of 90 pounds of nickel-silver took three hours for the first heat and one hour 35 minutes for the second heat; the energy consumption was 53.6 and 29.2 kilowatt hour respectively.

The principal advantages to be ex pected from electric heating are (1 absence of gas currents, reducin spelter losses and making the main tenance of a reducing atmospher relatively simple; (2) lower sulphu contamination; (3) greatly enhance life of crucibles; (4) improved qualit of metal.

The further development of thi furnace was postponed, owing to th difficulty of obtaining carbons in Eng land at the commencement of th war. A description of the work i its complete form is, however, give with the object of encouraging other to devote their attention to the de velopment of a commercially practic electric furnace.

What is Beryllium?

In the April issue of *Mineral Foote Notes,* published by the Foote Min eral Co., Philadelphia, Prof. C. James of the New Hampshire College, Dur ham, N. H., discusses beryllium, whic he states is an element, the occur rence of which in the combined stat is by no means so uncommon as on is generally led to believe. It is als a substance about which much ha been predicted and little accom plished.

The facts that there are only a fe industrial uses for the compound and at present practically no use for the metal, seem to be due to tw causes. First, that so few realiz the future possibilities of the miner sources. The mineral which is bot best known and commonest is bery It occurs in several localities in th eastern states and is widely distribute throughout the world. In many place it occurs massive and may be easil mined. It is true that many deposi are off the beaten track, but thes would readily become accessible a soon as the demand became grea enough.

The second cause is due to th difficulty in preparing the pure com pounds, for beryl itself is somewha refractory, and the separation fro aluminum none too easy. The sep aration of beryllium from aluminu deserves a careful and systemat study on a large scale. The litera ture on beryllium indicates severa possibilities, especially along lines o fractional precipitation. A very litt research will soon show that th manufacture of beryllium salts upo a large scale will cause the price t fall far below that existing at th present time.

Many of the beryllium minera are of interest, since, when perfe and of good color, they are use jewelry. The emerald, which is fine green variety of beryl, occurs the world-famed Muzo mine near ogota in Colombia and at Coscuez d Somondoco. It is also found in ıssia, New South Wales, etc.

Chemical Extraction

For the extraction of beryllium lts, the common large opaque beryls e used, of which single crystals are metimes found weighing more than ton. This material contains on e average a little more than 12 r cent of the oxide.

One of the simplest methods for e working up of beryl consists in sing the finely powdered mineral th an equal weight of sodium droxide. The resulting product is eated with sulphuric acid to convert e beryllium and aluminum to sulıates, after which the mass is heat- to render the silica insoluble. pon boiling out with water, the ryllium and aluminum are found in lution along with sulphate of sodin.

It is usual to separate the beryllium om aluminum by taking advantage of e fact that the former is soluble in nmonium carbonate or sodium bicarınate solutions, while the latter is soluble.

In carrying out research upon the paration of beryllium from aluinum, it is always well to remember at beryllium will give many reacıns differing from aluminum, yet hen the two are mixed together this ıe of demarcation is found to exist longer. Perhaps it would always advisable to follow up such reactions; for might it not be possible to find the conditions under which each substance followed its normal behavior?

Beryllium hydroxide exists in several forms, one of which resembles aluminum hydroxide in its properties, while another is said to resemble magnesium hydroxide. It is therefore evident, if these two forms occur, that the best condition for the separation will be to have the beryllium hydroxide present in the form where it resembles magnesium, because in this state the two substances present the greatest differences.

The writer is of the opinion that either fractional solution or fractional precipitation will be finally found to give a very cheap method for the production of compounds of the element under discussion.

Metallic Beryllium

The metal itself is still little known. The chloride is easily reduced by sodium, yielding the metal in the form of silvery globules. Unfortunately the anhydrous chloride which must be used for this purpose is very troublesome to make and it becomes necessary to find a process more easily followed.

Metallic beryllium is said to be obtained by the alumino-thermal reaction. The beryllium oxide is reduced by aluminum by heating the mixture until the reaction commences and then rapidly applying external heat, so that a temperature above the melting point of the metal is reached. This process, which has been quoted as giving a metal of 90 per cent purity, is patented in Germany.

The ideal method, toward which all look forward, will be parallel to that used for the extraction of aluminum. It is highly probable that a great deal of work will have to be performed before this is achieved, and it is to be expected that the process will not run quite as smoothly as in the similar case.

Beryllium Compounds

Since the element appears to be malleable, light and silvery in appearance, and since it is permanent in air and apparently not affected by water, it would seem to possess some very good properties. Several alloys have been prepared. Those with copper resemble the corresponding ones of aluminum and copper. One and one-half per cent of beryllium makes the copper assume a yellow color, while 5 per cent makes a golden yellow alloy.

Beryllium oxide is perhaps the most important compound as yet, for it has several industrial applications. It is used in the manufacture of incandescent mantles in order to make them stronger. The amount used depends upon the manufacturer. Some makers use 5 grams of beryllium nitrate to every kilogram of thorium nitrate, while others use only 2 grams to the same quantity of thorium salt. The addition of the beryllium salt is very useful in the manufacture of mantles possessing some definite form.

The oxide is sometimes added to material that is being used for the manufacture of abrasives.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Porous Copper Castings

We are making a mixture consisting copper, 88 per cent; tin, 6 per cent; ıd, 3 per cent, and zinc, 3 per cent, ıt the castings invariably are porous. e are wondering if by changing the ixture to 85 per cent copper, 6 per nt tin, 6 per cent lead and 6 per cent ıc, using phosphor-copper as a flux, tter results could be obtained. What the most suitable flux for preventing idation in an oil-fired furnace of the t type?

The mixture comes porous because e metal is allowed to absorb oxygen d other gases while it is being melted. ıanging the mixture will not overcome the difficulty. The use of phosphor-copper is advisable, although it must not be presumed that its use will obviate porosity unless precautions are taken while melting. For an oil-fired furnace the most suitable flux is one of a sticky nature, as the force of the flame sweeps away the charcoal. Green bottle glass makes a good flux. Use the glass in conjunction with powdered anthracite coal and a little salt. Have the surface of the metal entirely covered.

If the proper precautions are used in melting the mixture, and if the flux is made up of the materials mentioned above, the porousness which you have experienced should disappear.

Melting Copper in Cupola

We have an order for three bronze castings weighing approximately 3,000 pounds each, to be made of the following composition: Copper, 82 per cent; lead, 10 per cent; tin, 4 per cent, and zinc, 4 per cent. Our brass furnace has a capacity of only from 800 to 1,000 pounds, but we have three iron cupolas which could be used in making the melt. I would like to know the best way to make these castings, either in the cupola or in some form of brass furnace which we could construct here.

Mix the proportions of lead, tin and zinc in crucibles in a separate furnace and melt nothing but copper in your iron cupola, being quite sure the latter is thoroughly cleaned beforehand.

Melt preferably with a low sulphur anthracite coal. You can, however, use one-half coke and one-half anthracite, in which case you will have additional sulphur trouble to contend with.

Melt as in ordinary gray iron practice, being very careful not to blow too long, using 8 to 10-ounce blast pressure, and stop blowing as soon as the copper is melted. Tap out into a large ladle and add the crucible mix while the ladle is in process of filling. Slant your cupola bottom well toward the tapping hole to permit of all metal running out. You will, of course, understand about charging enough metal to make up for any losses.

After tapping the iron cupola, we advise the use of lump charcoal on the top of the metal to prevent oxidation due to atmospheric conditions. Oxidation does not necessarily occur during the process of melting the copper, but after the metal has become fluid, then oxidation will occur very rapidly. Do not overheat or use the blast any longer than necessary to melt the copper.

The melting points of the tin, zinc and lead are so low compared to the copper, that they readily dissolve in the molten copper, thereby eliminating one of the greatest dangers in crucible melting, chiefly caused by the oxidation of zinc and tin.

All that is necessary by this method would be to bring the tin, zinc and lead up to a fluid point, in order not to chill the copper too much and to bring about a more uniform mixture in the large ladle. Care should be exercised in melting the copper to use a low sulphur fuel.

White Aluminum Alloy

We would like to have the mixture of an aluminum alloy which will have a white appearance when polished.

The following alloy will be found to be as white as it is possible to make alloys of aluminum: Aluminum, 81 per cent; copper, 2 per cent; tin, 2 per cent, and zinc, 15 per cent.

Flux for Brass Particles

On page 157 of the April issue of *The Foundry* was published the analysis of a mixture under the caption of "Flux for Small Brass Particles". The component parts of this flux were given as follows: Lime, 10 per cent; powdered fluorspar, 30 per cent; salt, 10 per cent, and soda ash, 20 per cent. In place of per cent the components should have been given in parts.

White Metal for Art Work

We would like to cast small statuettes and busts in zinc or a white metal mixture and we would like to have you furnish us with with the components of such an alloy. Also, we would like to have a fairly hard, sharp casting, silver-like alloy, suitable for making pendants for watch fobs.

The following alloy will be satisfactory for statuettes: Lead, 80 per cent, antimony, 10 per cent, and tin, 10 per cent.

For pendants for watch fobs use tin, 89 per cent; antimony, 8 per cent, and copper, 3 per cent.

In making the latter alloy, melt the copper separately in a graphite crucible, add the antimony and about 15 per cent of the tin. Melt the remainder of the tin separately and pour the copper-antimony-tin alloy into the molten tin, stirring it thoroughly in the meantime.

Lining for Melting Furnace

Can a satisfactory lining for an oil brass melting furnace be made from ordinary fire clay and sand? If so, kindly let me know what proportions of each to use. I would like to place a wood core in the center of the shell and ram in the clay the same as in a mold. Should it be very soft for this or only slightly moist?

Whether a satisfactory lining can be made from the materials named will depend upon their quality. If the sand is white silica and the fire clay low in alkalies and iron oxide, they will make an excellent lining if mixed in the proportion of 32 per cent clay and 68 per cent sand. This will give a mixture containing around 80 per cent silica and from 7 to 8 per cent alumina, corresponding to the composition of a good ganister. The mixture should be dampened with water like wet molding sand and should be well rammed into place.

Magnalium Castings

I have been endeavoring to make some small castings of magnalium for surgical instruments. Can you tell me how this metal is mixed; that is, should the aluminum be melted first and the magnesium added, or should both be melted at the same time? I have had trouble with an experimental heat. The entire mass was badly burned.

In making aluminum alloys always reserve a small portion of the charge for cooling purposes, as it is very easy to heat aluminum to a cherry red in an ordinary brass melting furnace. This temperature is harmful to the aluminum. In making magnalium, heat the aluminum to a just visible redness and add the magnesium. The latter metal melts at 633 degrees Cent., and th aluminum will be at a temperature be tween 700 and 800 degrees Cen Therefore, the magnesium will readil melt and alloy. If the aluminum acc dentally gets to a full red, use the re serve metal for cooling. The pourin temperature will depend upon the thi ness of the castings. Very thin cas ings will have to be poured at 800 t 850 degrees Cent. in order to run then Heavy castings poured at this ten perature will be worthless. Therefor pour as cool as possible consistent wit running the work. Use a tough mol ing sand that can be worked quite dr and will hang when soft rammed.

Mixture to Hold Gasoline

We would like to have a mixture f valve stems and cages for gasoli pumps and we find that a metal th will withstand steam and water pressu will not hold gasoline. At present w are using 80 per cent copper, 8 per ce tin, 7 per cent lead and 5 per cent zin with the addition of a small amount phosphor-copper, approximately ¼ pou to 100 pounds of metal. This alloy h a tendency to tear when grinding t seat. We would like to have a mixtu that will machine easily and which c be ground satisfactorily.

We suggest a trial of the followi mixture: Copper, 78 per cent; tin, 7 p cent, and lead, 15 per cent, using for deoxidizer about the same amount phosphor-copper as in the alloy give

Facings for Brass Castings

Kindly let us know whether plumba can be used satisfactorily as a faci for molds for brass castings. What the best mixture to use for brass bolt

Plumbago frequently is used as coating on molds for producing bra and bronze castings, particularly wh the latter are massive, but it is n required for some castings. It usual is applied dry with a camel's hair bru and afterwards may be slicked or p ished by the fingers or with moldi tools. The plumbago is painted large dry sand molds in the form a wash of the consistency of crea The wash usually is made by mixi plumbago with weak molasses wat For some small brass castings, flo usually is dusted over the molds a this is blown off by the bellows or a jet.

A good mixture for brass bolts f lows: Copper, 89.5 per cent; tin, per cent; zinc, 3 per cent, and lea 1.5 per cent.

If a very strong alloy is desired, t following is recommended: Copper. per cent; zinc, 40 per cent; tin, per cent, and aluminum, 0.5 per ce

A Study of Inclusions of Alumina in Steel

With Our Present Knowledge We Cannot Be Sure That Alumina Particles Will Not Segregate in Castings or Ingots

By George F Comstock

THE subject of non-metallic inclusions in steel is one that has attracted remarkably little attention among students of metallography considering the vast amount of work that has been done in recent years in the investigation of metallic structures with the microscope. Indeed the tendency is still far too common among metallographists to give the general name slag to all substances seen in polished steel surfaces that are not metal. This is especially unfortunate in regard to sulphides, which obviously are not slag, and it should be equally desirable to distinguish between other typical inclusions, such as silicates of iron or manganese, iron oxide or scale, alumina, and titanium nitride. The objects of this paper are to call attention to the fact that alumina can be distinguished from other non-metallic inclusions in steel, to indicate how it can be recognized, and to show a few examples of the harm arising from it when locally abundant.

In the literature dealing with inclusions in steel there are but few references to alumina. One of the earliest of these, and also the most definite, is in an article by Heyn and Bauer, entitled "Kupfer, Zinn, und Sauerstoff", published in the *Zeitschrift fur Anorganische Chemie*, 1905, No. 45, page 63. This reference to alumina, freely translated from the German, is as follows:

"The film-like enclosures of tin oxide in bronzes bear much similarity to the enclosures in mild steel which has been deoxidized with aluminum instead of manganese. A photomicrograph, Fig. 1, shows such enclosures which consist, as found by analysis, of alumina. Also, in copper-magnesium alloys similar enclosures can be observed which are due to thin films of magnesium oxide."

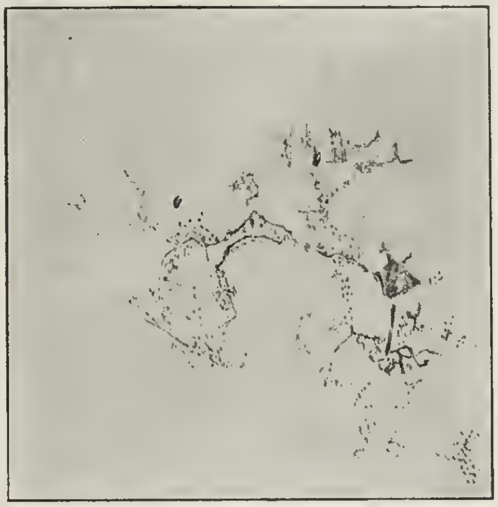


FIG. 1—ALUMINA IN STEEL DISCOVERED BY HEYN AND BAUER

Fig. 1 is a transparency copy, made by the United States bureau of standards of the photomicrograph published by Heyn and Bauer to show the alumnia inclusions, magnified 29 diameters. This same photomicrograph was used by Martens and Heyn in "Materialenkunde fur den Maschinenbau", No. 2A, page 207, from which the following is quoted and translated freely:

"A similar case (of non-metallic inclusions) can also be found in mild steel to which aluminum has been added before the deoxidation is complete. The alumina arising from the combination with oxygen is held in the metal on account of its infusibility and forms foam-like films which are visible after solidification, as shown in Fig. 1 (referring to the same photomicrograph, magnified 29 diameters, first published by Heyn and Bauer). The dark lines and specks are Al_2O_3. A steel which after solidification contains such foam-like films is not workable, but will crumble when forging at a red heat is attempted. A piece of such steel was found to be extraordinarily red-short, and when rolling was attempted it split and formed collars on both the upper and lower rolls."

Referring to the use of aluminum as a deoxidizer, and the resulting formation of alumina, Dr. Walter Rosenhain, in his "Introduction to the Study of Physical Metallurgy", page 153, writes as follows:

"A more powerful deoxidizing agent than manganese is furnished by aluminum, but this differs from manganese in two vitally important respects. In the first place, the oxidation product of aluminum is a particularly refractory substance, alumina, which has a strong tendency to remain in the molten metal in suspension as fine particles. These, of course, tend to lessen the strength and toughness of the alloy."

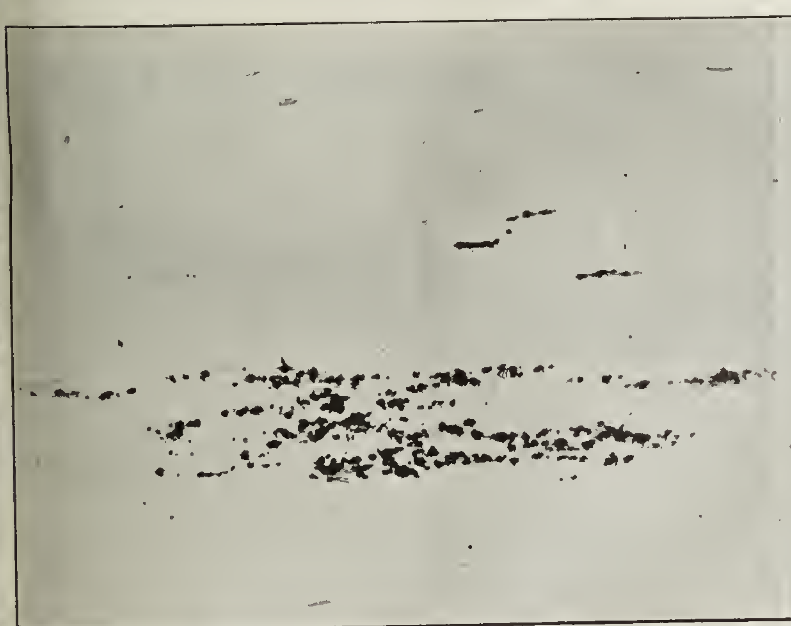


FIG. 2—ALUMINA INCLUSIONS IN A BAR OF AMERICAN STEEL

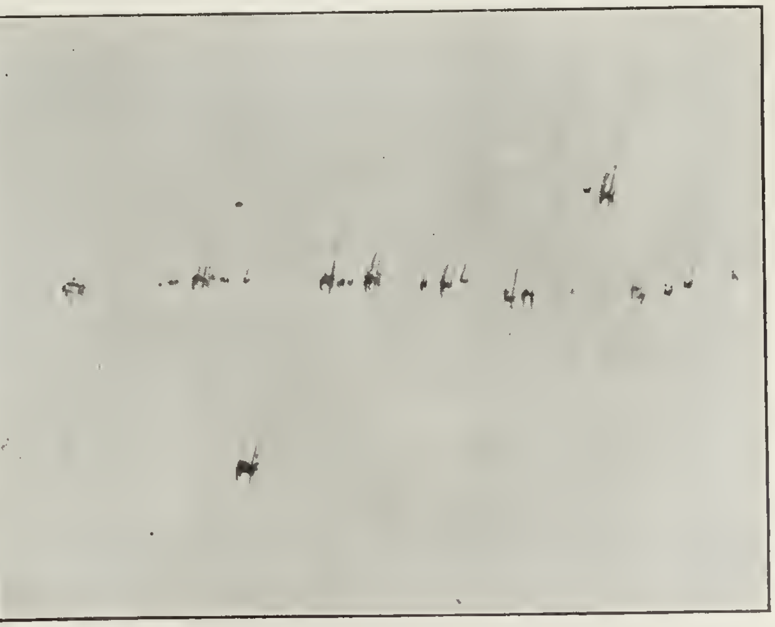


FIG. 3—ALUMINA PITS APPEARING IN THE FORM OF SHORT SCRATCHES

A paper read at the annual meeting of the American Foundrymen's Association, Cleveland, Sept. 11 to 15, 1916.

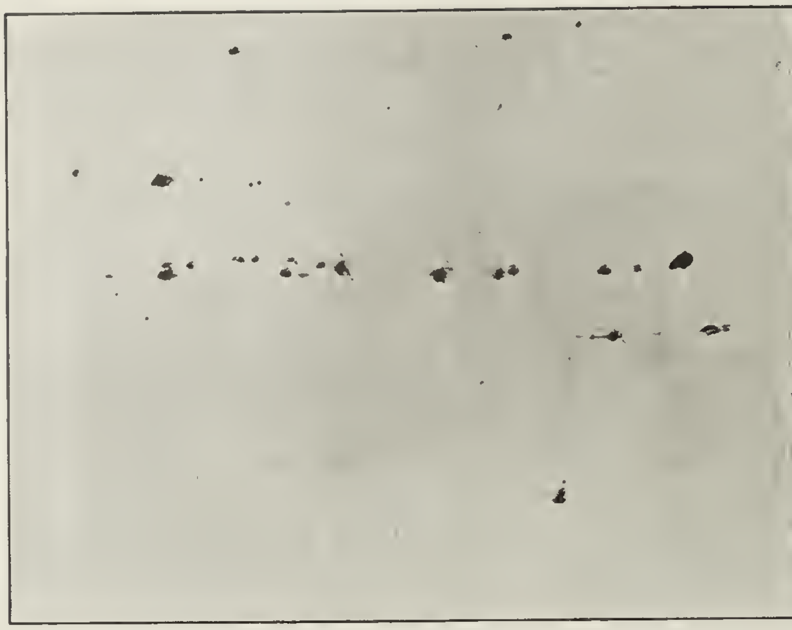


FIG. 4—SAME STREAK OF ALUMINA PARTICLES AS SHOWN IN FIG. 3 AFTER GRINDING AND MORE CAREFUL POLISHING

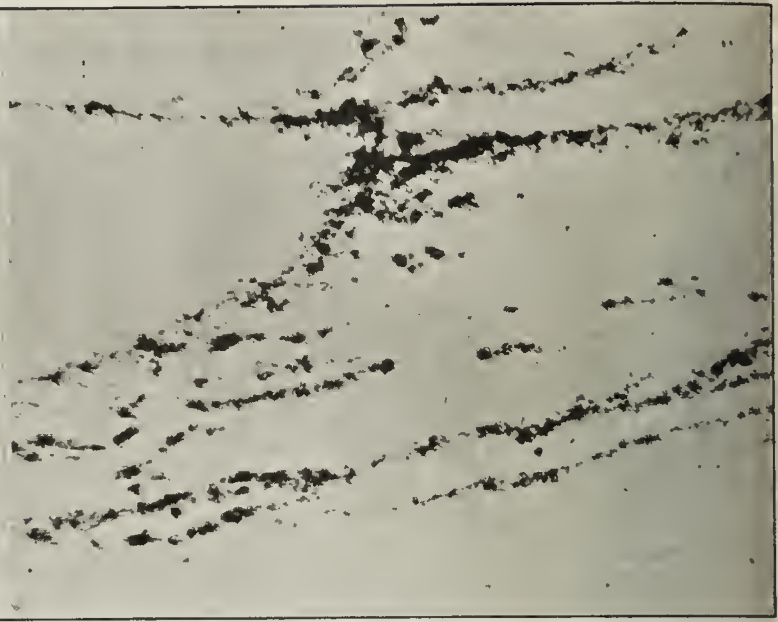


FIG. 5—BAR OF STEEL SHOWING CHARACTERISTIC DISTRIBUTION OF INCLUSIONS OF ALUMINA PARTICLES

In a paper entitled "The Solid Non-Metallic Impurities in Steel", published in the *Transactions* of the American Institute of Mining Engineers, Vol. XLI, pages 803-822, Henry D. Hibbard writes, in part, as follows:

> "If other elements have been added, such as aluminum, chromium, or vanadium, their oxides and silicates may be present. * * * The too plentiful use of aluminum in steel may have been condemned, partly at least, because it forms oxides or silicates in the metal, which, being insoluble, and infusible, exist in the solid steel as very harmful sonims. Of course, to form the oxide there must still be some oxide of iron or manganese in the steel. If the metal were free from oxygen perhaps the weakening effect of aluminum * * * would not occur."

The various writers quoted above unmistakably recognize the existence of alumina as a frequent non-metallic impurity in steel. They are aware of the potential harmfulness of this impurity, but they do not give any idea as to how it may be recognized and identified in metallographic work. To supply this deficiency was the object of the author's article on "Alumina in Steel", published in *Metallurgical and Chemical Engineering,* Dec. 1, 1915. This article described the experiments made to ascertain the characteristic appearance of alumina in steel, and showed numerous photomicrographs to illustrate it. The work will not be gone over in detail here, as the original article can easily be referred to, but some of the typical photomicrographs are shown again with descriptions of alumina inclusions and the points wherein they differ from sulphides, slag, etc.

Fig. 2 shows the inclusions in the first bar of steel that came to the author's attention, in which alumina was known to be present. The inclusions are in the form of small rounded spots, arranged close together in one elongated streak. They are of a very dark bluish-gray color, when examined with the white light of an electric arc, appearing black unless highly magnified. It was almost impossible to polish them without forming little pits around each inclusion. If the polishing is done very carefully, these pits may be kept very small; but with certain methods of polishing the pits are made so large that the original inclusions cannot be seen at all. If the specimen is not rotated continuously during the final polishing, the pits take the form of short scratches, and each inclusion will have a little tail like a comet. This is illustrated in Fig. 3, while Fig. 4 shows the same streak of alumina particles after grinding and more careful polishing.

Fig. 5 shows another bar of steel, like Fig. 2, in which the occurrence of alumina was assured, and the general similarity of form in these two instances is apparent. Although these both show longitudinal sections of forged bars, the individual inclusions

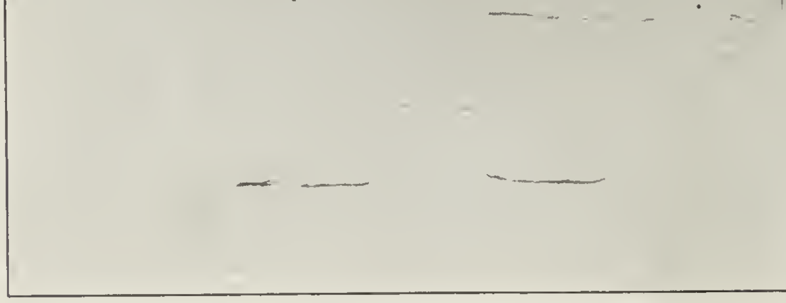


FIG. 6—TYPICAL SILICATE INCLUSION IN ROLLED STEEL BAR

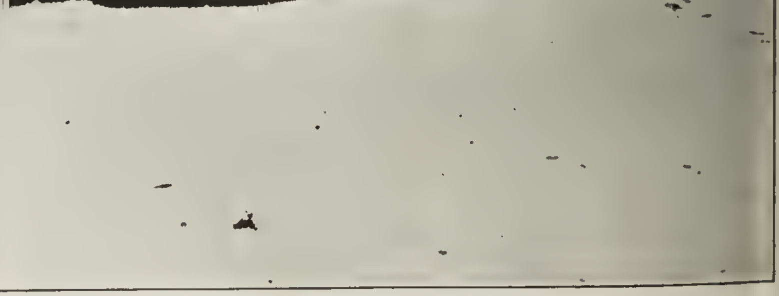


FIG. 7—ANOTHER EXAMPLE OF SILICATE INCLUSIONS IN STEEL

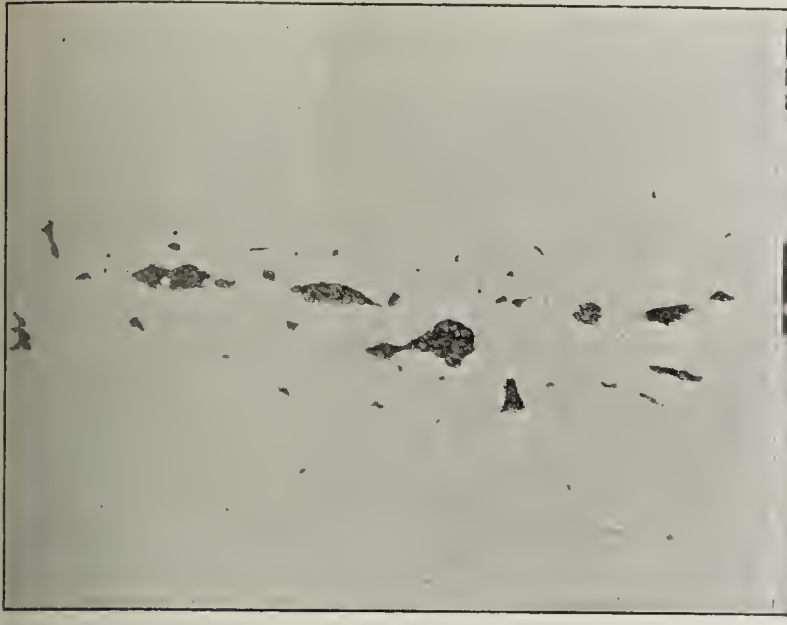


FIG. 8—COMPLEX SLAG INCLUSIONS IN STEEL

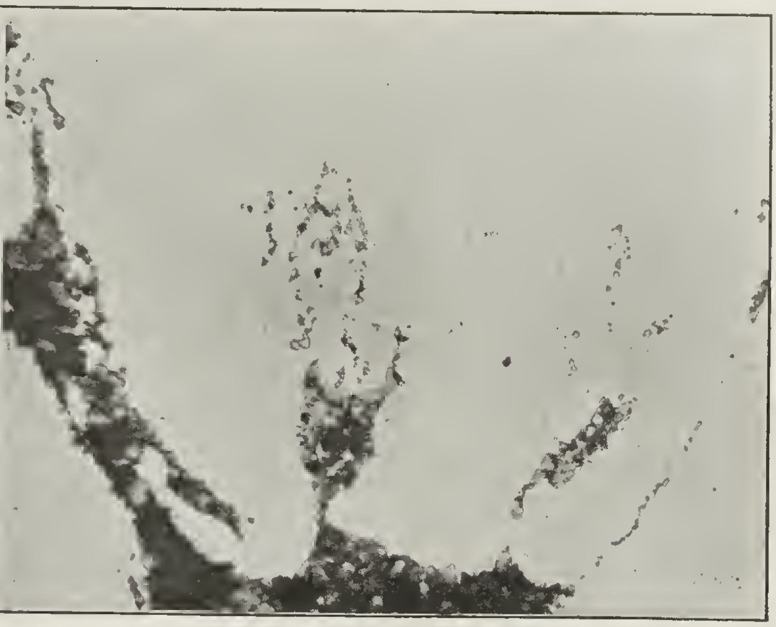


FIG. 9—CHROMIUM OXIDE EMBEDDED IN STEEL

have not been elongated by the forging, but merely the groups of particles have been drawn out into streaks. Compare these with Figs. 6 and 7, showing silicates in rolled bars, and a great difference is evident at once, for the individual silicate particles are very much elongated in the direction of rolling. It should perhaps be noted here that there is no difference between rolling and forging in their effects on particles of either alumina or silicates.

The differences between inclusions of alumina and ordinary slag or silicates in steel were summarized as follows: (1) Silicate inclusions will generally take a fairly smooth polish in a section prepared for microscopic examination, while alumina is very hard to polish without pitting. (2) Silicate inclusions are always elongated in the direction of rolling or forging, while alumina particles are not. The groups of particles are of course elongated, but not the particles themselves. (3) Silicate inclusions are often found of quite large size, as well as very small, while particles of alumina are always small, and do not seem to coalesce into large bodies even when closely grouped together. These characteristics of alumina inclusions agree with what is known of the properties of alumina. Its great hardness and brittleness would account for the pitting effect; its infusibility would account for the small size of the particles and the tendency not to coalesce; and both of these properties together would account for the particles not being elongated by forging or rolling of the steel in which they are embedded.

Appearance of Alumina

My former article, pointed out that no other substance was known that had exactly the same appearance as alumina in a polished steel section, and this statement still holds true. Fig. 8 shows some complex slag inclusions, probably containing titanium, since the steel was treated with oxide of titanium before casting. Evidently it cannot be said that this oxide looks like alumina. Fig. 9 shows oxide of chromium embedded in steel. These resemble alumina slightly in a photograph, but when seen directly through the microscope they may be distinguished by their smooth polish and purplish color. Fig. 10 shows the inclusions in steel treated with nickel oxide. These are probably oxide of iron, and could not be mistaken for aluminum. Titanium nitride crystals are easily identified by their angular form and pink or orange color, which is shared by no other substance in steel. The differences between silicates and alumina have been pointed out above, and sulphides are of course known to nearly all metallographists by their smooth dove-gray appearance. Thus the appearance of alumina is believed to be distinct, and warrants the identification of this substance in steel by metallographic examination.

The author's work in establishing this identification was based largely in checking the microscopic evidence by chemical analyses. It was stated in the previous

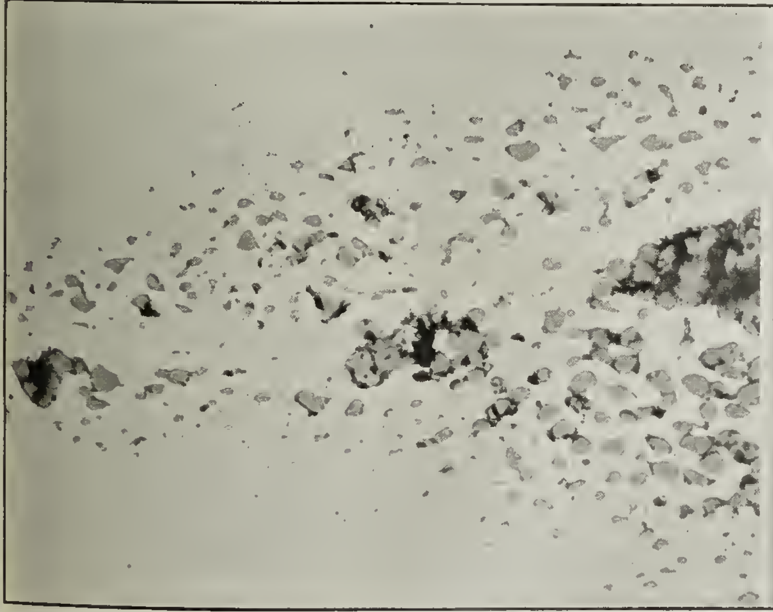


FIG. 10—INCLUSIONS IN STEEL TREATED WITH NICKEL OXIDE

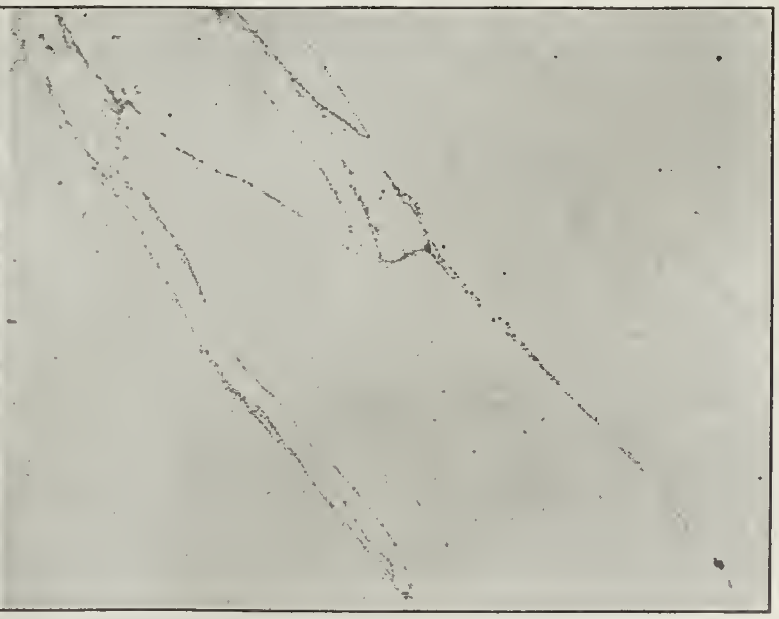


FIG. 11—ALUMINA PARTICLES IN SAME SAMPLE AS SHOWN IN FIG. 5 BUT MAGNIFIED LESS (Sauveur)

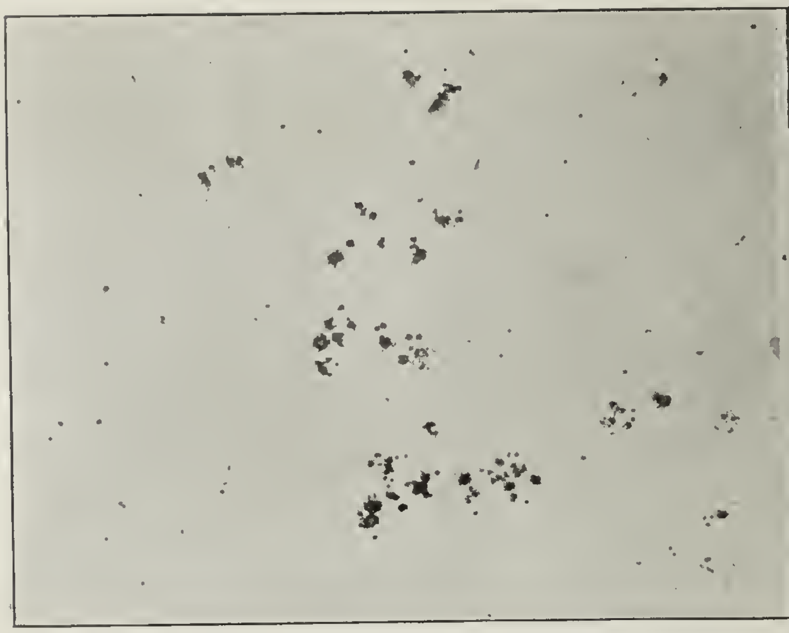


FIG. 12—ALUMINA INCLUSIONS IN A SOFT STEEL CASTING

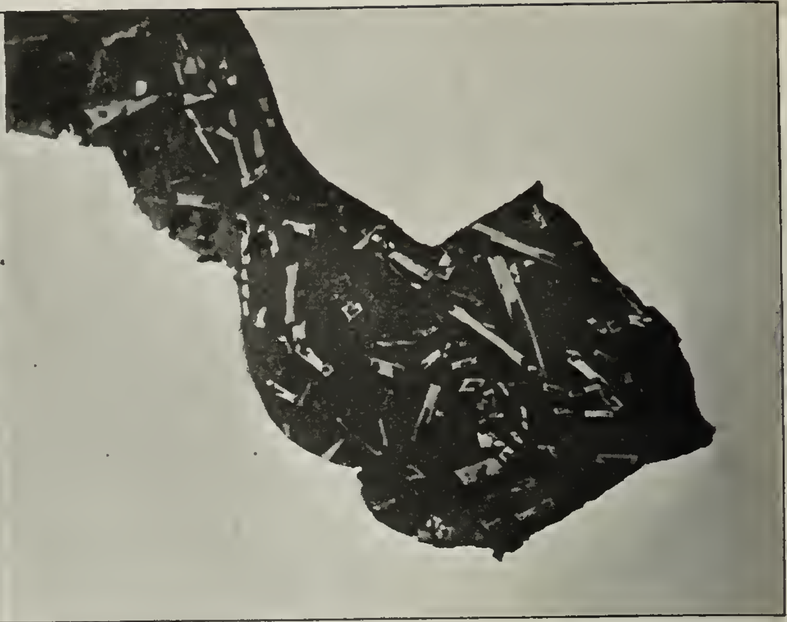


FIG. 13—LARGE, TYPICAL SLAG INCLUSION IN STEEL CASTING

article that all samples in which more than the merest trace of alumina was found by analysis were seen to contain the typical inclusions as described above, and those in which alumina was not found by analysis, did not contain these inclusions. Furthermore, those in which more alumina was found by analysis contained more of these inclusions than those in which only a very little was found. It might perhaps be well to mention the fact that these analyses were not made under the author's direction, but in a different laboratory, and neither the chemist nor the metallographist knew each other's results until the work of both on any given sample was completed. The methods in the chemical determination of alumina in steel are described in the booklet "Ferro Carbon-Titanium in Steel Making", Titanium Alloy Mfg. Co., pages 99 to 105, and in the course of his remarks on the chemical side of the work, the writer, L. E. Barton, states that "the results show conclusively that alumina may occur in the free state in steel, and greatly strengthen the probability that free alumina may be detected by metallographic examinations."

The well known metallographist, Prof. Albert Sauveur, of Harvard University, has recently completed an independent investigation dealing with the occurrence of alumina inclusions in steel, in the course of which he examined some of the author's specimens as well as some that he himself prepared. His report of this work was published in the Aug. 1, 1916, issue of *Metallurgical and Chemical Engineering* and in the *Iron Age* and *Iron Trade Review* for July 27, 1916. Fig. 11, on page 199, is a photomicrograph taken by Prof. Sauveur of the same sample shown in Fig. 5, but magnified only about 36 diameters. It illustrates well the "filmy" arrangement sometimes assumed by alumina particles, as mentioned by Martens and Heyn, quoted above, and represented by Heyn and Bauer in Fig. 1. A comparison of Figs. 11 and 5 indicates that the "dark lines" said to be Al_2O_3 in Fig. 1, which is magnified only 29 diameters, were in all probability made up of fine rounded particles like those described by the author and shown in Figs. 2 and 5. The conclusion reached by Prof. Sauveur was that "alumina inclusions may be distinguished under the microscope from the other inclusions generally occurring in steel, being characterized by their small size, their dark coloration, and more especially by a complete absence of elongation in the direction of the rolling or forging."

It may seem that the characteristic appearance of alumina inclusions, as compared with slag or silicates, is only exhibited in worked steel, but this is not the case. The identification of alumina in cast steel calls for more care and experience than in worked steel, for small silicates here exist as globules instead of fibers, and might perhaps be mistaken for alumina if carelessly polished and examined. But the very dark color of alumina, its

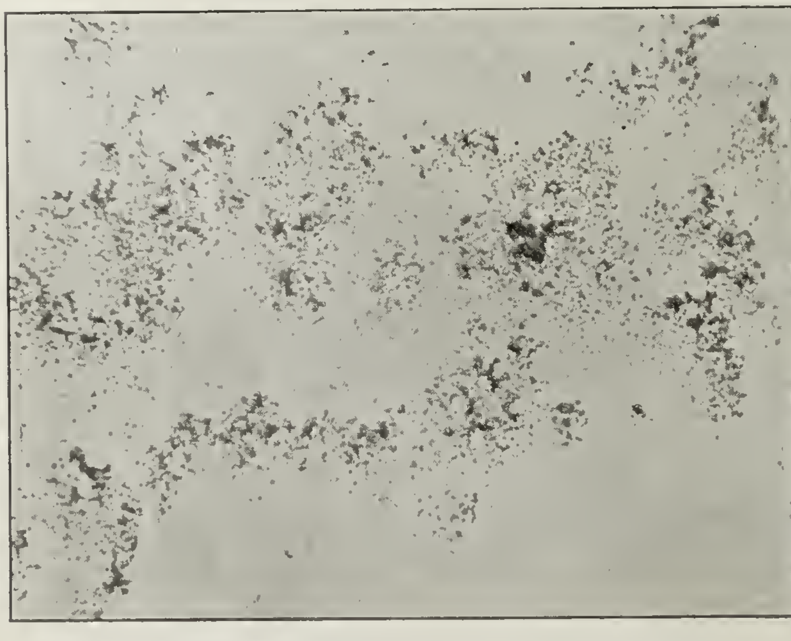


FIG. 14—SECTION NEAR TOP OF AN INGOT WHERE ALUMINA CONTENT WAS UNUSUALLY HIGH

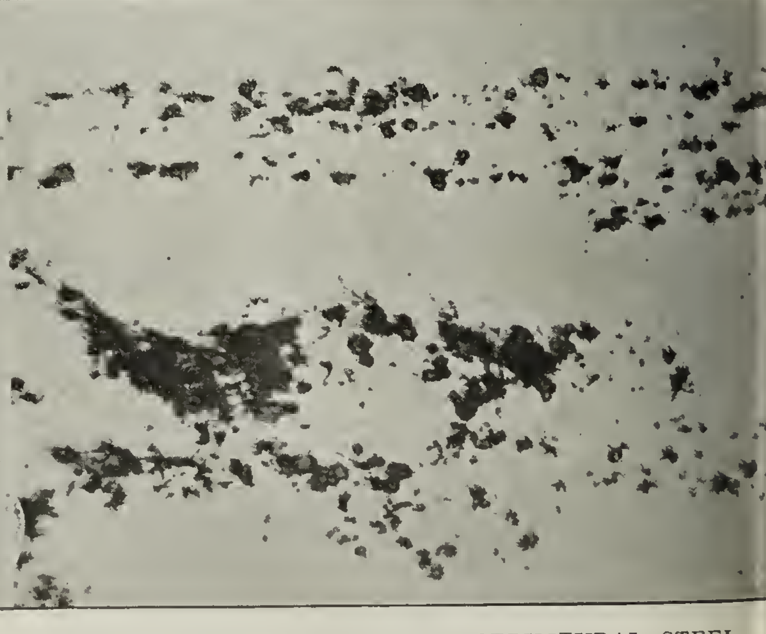


FIG. 15—WEAK STREAKS IN A STRUCTURAL STEEL BLOOM

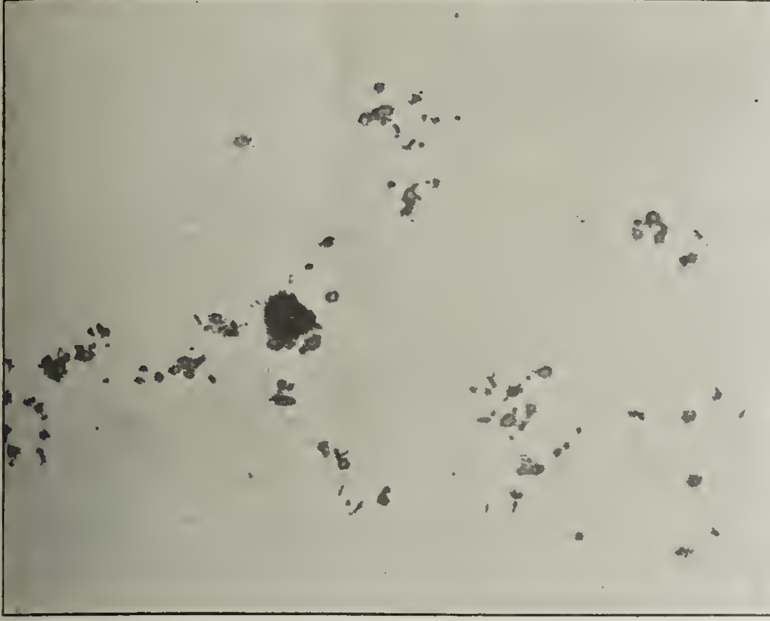


FIG. 16—ALUMINA PARTICLES NEAR FRACTURE IN LOCOMOTIVE TIRE

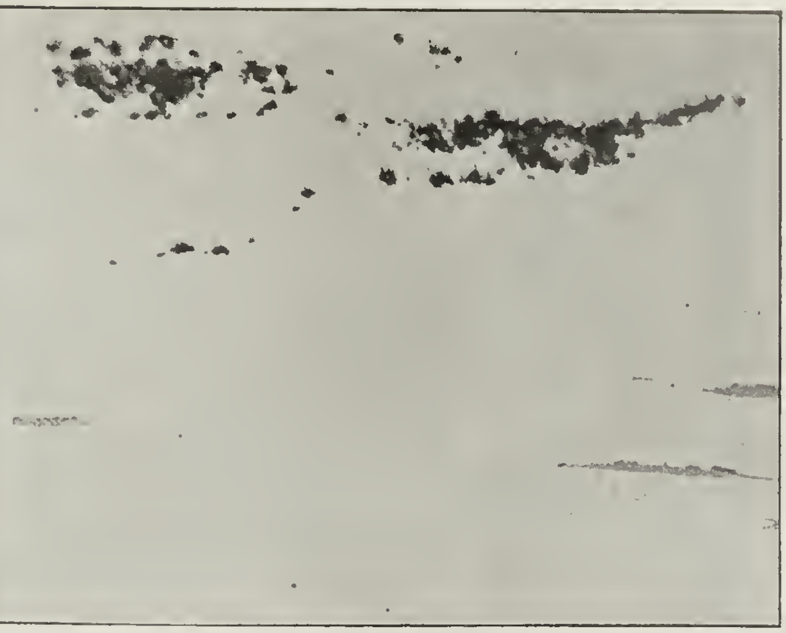


FIG. 17—ALUMINA AND SULPHIDE PARTICLES IN A FAILED RAIL

rough appearance and the pitting effect, and the invariably small size of the individual particles are sufficiently distinctive characteristics to enable it to be recognized in castings as well as forgings, especially if the observer is careful and already familiar with its appearance. Fig. 12 shows these inclusions in a casting of soft steel, where the presence of free alumina was established by chemical analysis of the insoluble residue from a large sample. Fig. 13 shows a fairly typical though large slag inclusion in another casting, and the sharp outlines of the slag, as compared with the rough appearance of the alumina, are clearly brought out. This slag, moreover, as is often the case, is evidently not homogeneous, but of duplex composition. Fig. 14 shows a section near the extreme top of an ingot, where the alumina content was excessively high. This foamy appearance is rare, but to a certain extent it resembles Fig. 1, as described by Martens and Heyn. The usual aspect of alumina in cast steel is the same as in forged or rolled steel, with the single exception that when the particles are grouped closely together in certain spots, these groups are of irregular or rounded shape in castings, instead of being elongated into streaks as in a rolled bar.

A similar difficulty to that experienced in castings may be encountered in cold-worked steel, such as wires, tensile test bars after pulling, etc. Here the slag or silicate fibers are usually broken up into fragments and drawn out into streaks, but if carefully polished the fragments of silicates can be recognized by their definite and angular outlines and their smooth surface, while alumina particles will be rougher, probably more or less pitted, and less distinctly outlined.

It is not desired to give the impression by this paper that alumina always exists in steel in the form of such large groups of particles as those shown in the photomicrographs. Its most usual mode of occurrence is probably in isolated particles, thinly scattered through the metal, and in this form it is practically harmless. The danger in its use as a deoxidizer lies in the fact that with our present knowledge, or under present mill conditions, we can never be sure that the alumina particles will not segregate or gather together in certain parts of the casting or ingot. When this happens the results are dangerously weak streaks such as is shown in part in Fig. 15, taken from a bloom intended for structural steel. Such streaks may not be common, but they nevertheless do occur when aluminum is used, and may cause great harm. A few examples will be mentioned in closing where failures in service could be directly traced to the presence of alumina.

Fig. 16 shows a group of alumina particles near the starting point of the fracture of a large driving tire on a railroad locomotive. No other defect could be found to explain the failure, except the presence of too much alumina, segregated in spots through the metal. Fig. 17 shows part of a streak of alumina and sulphide particles that caused the top of the head of a rail to break and shell off in the track. The contrast in appearance between alumina and sulphides is well brought out in this photomicrograph. Fig. 18 shows a section of a thin steel plate, on which blisters appeared after hot-rolling. A large streak of alumina was found near the surface of the plate, and part of this streak is shown in the photomicrograph. The black strip along one edge is space beyond the edge of the section, or beyond the surface of the plate, and the other long black spots are sections of blisters, the bright areas being, as in all the other photomicrographs, the polished surface of the steel. The metal evidently tore through the alumina streak, as the blisters are seen to lie in it, and the contraction of the hot interior of the plate after rolling caused the cooler outside layer to bulge outward, forming blisters where the separation or tearing in the alumina had taken place.

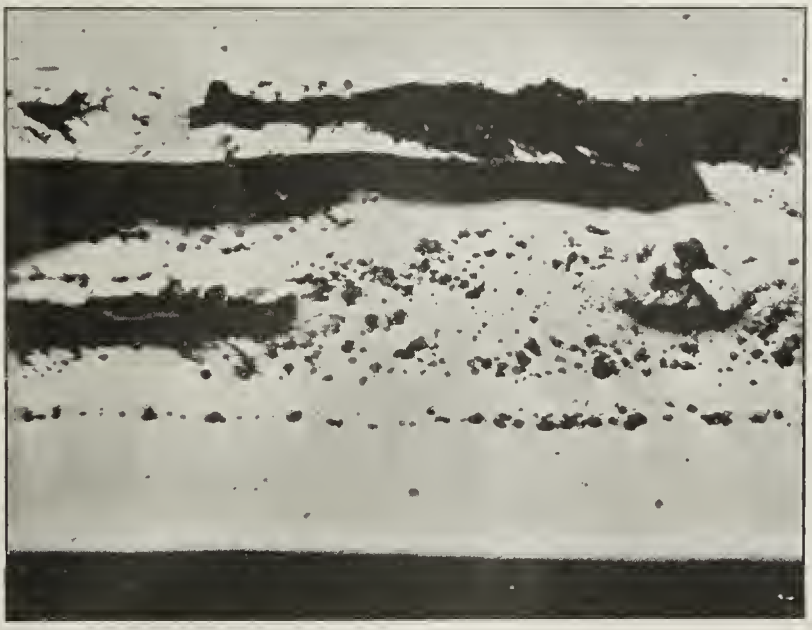


FIG. 18—SECTION OF A BLISTERED THIN STEEL PLATE

Before closing, it should be mentioned that all the photomicrographs, except Fig. 1, copied from a tracing by the bureau of standards, and Fig. 11, taken by Prof. Sauveur, were made at a magnification of 200 diameters, and no etching reagent was used.

Hamilton & Hansell, 17 Battery place, New York City, have received an order from the Chicago Bearing Metal Co., Chicago, for two 1-ton Rennerfelt electric arc furnaces, rated at 300 kilowatts each, to be used for melting copper alloys.

Mixture for Cylinders

By W. J. Keep

Question: — In the very near future we intend to engage in the manufacture of cylinder castings and we would like to know what iron mixture is best adapted to this work.

Answer: — The accepted standard analysis for cylinder castings follows: Silicon, 1.75 to 2 per cent; sulphur, under 0.08 per cent; phosphorus, 0.40 to 0.50 per cent; manganese, 0.60 to 0.80 per cent; combined carbon, 0.55 to 0.65 per cent, and total carbon, 3 to 3.25 per cent. You can approach this composition with irons obtainable in your market. However, if your phosphorus runs up considerably, it will do no appreciable harm.

Measuring Furnace Oil Without Using a Meter

By E Tonkin

A NOVEL method of measuring oil in a pressure tank without using a meter has proved satisfactory in securing data for comparing the cost of oil and natural gas fuel per ton of metal melted in a brass furnace. An oil tank, approximately 22 x 40 inches, was fitted up in the pipe shop with oil and air connections as shown in Fig. 1. The oil inlet was tapped into the center of the top head of the drum. By means of a *T* between the oil inlet valve and the drum, connection was made to an inlet air pipe and pressure gage. The oil line to the furnace was tapped into the lower head of the drum while an air outlet was fitted to the tank at a point on the side near the top head. Water glass valves were screwed into holes at two points in the side of the reservoir and were connected by a glass tube. A yard stick fastened in a parallel position alongside the glass served as a means of gaging the height of oil.

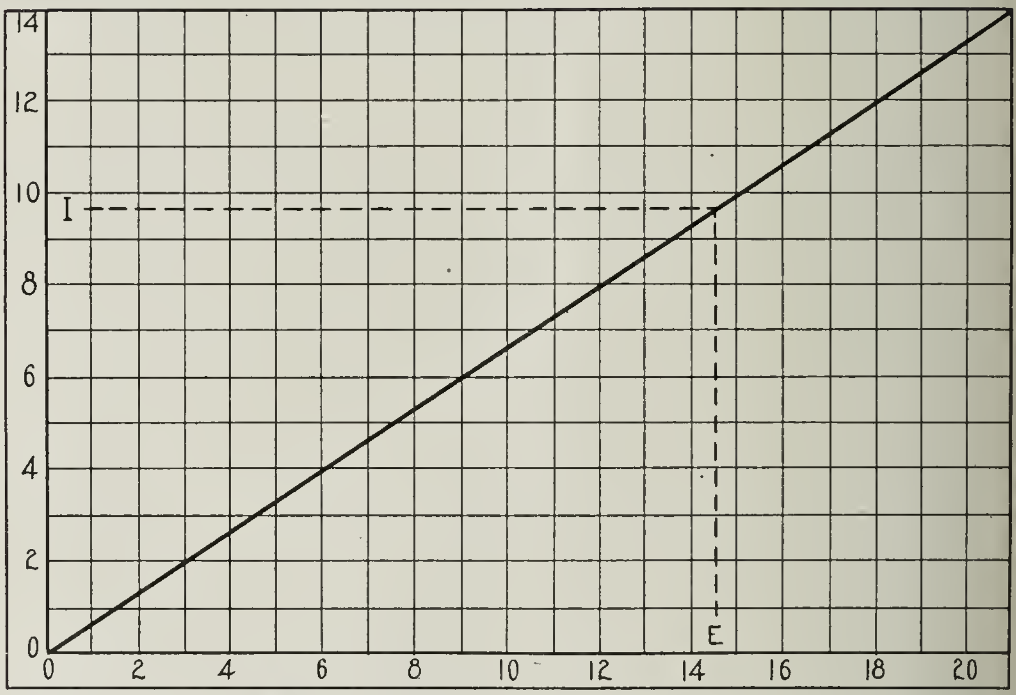


FIG. 2—PLOT SHOWING CORRESPONDING VOLUME FOR EVERY HEIGHT OF OIL IN THE RESERVOIR

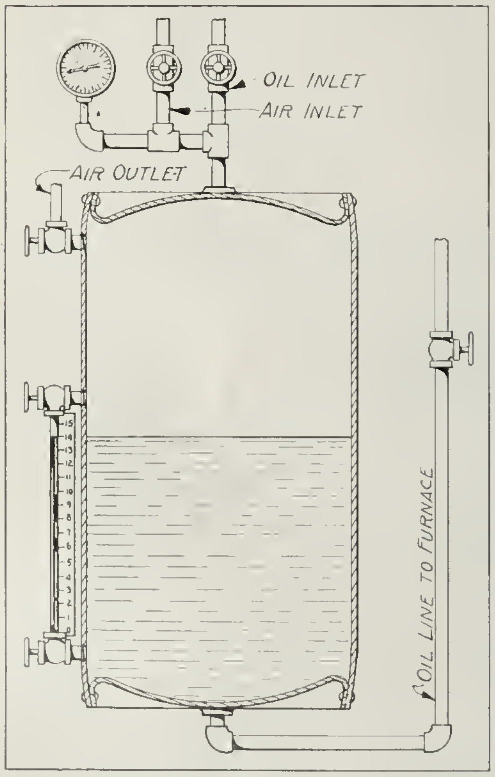


FIG. 1—ARRANGEMENT OF OIL RESERVOIR SHOWING METHOD OF CALIBRATION

The tank was calibrated by placing it on platform scales and weighing it, first when empty, and then with water at the level of each mark on the yard stick.

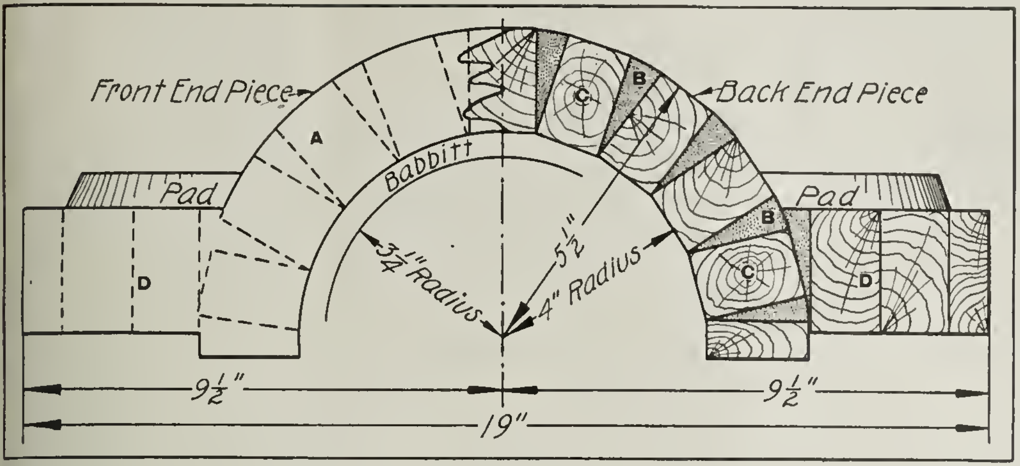
From these data was determined that 1 inch of water on the scale corresponds to a volume of 1½ gallons of water in the tank, therefore, the constant 1.5, may be used to convert the scale reading to a measure of the contents of the tank. The curve plotted in Fig. 2 was constructed on this basis.

The tank may be filled by reducing the pressure of air in the tank by opening the air outlet valve until the pressure is less than that of the incoming oil. When the tank is filled the air valve outlet may be closed and the pressure in the tank may be built up to that required for feeding the oil into the furnace. Time for filling the tank is provided while heats are being poured or while the furnace is being charged. An example of how easily this measuring device operates in actual service is given in the following test. In starting the heat the gage read 12.5 inches and at the end of the heat the reading was 2.75 inches. The number of inches of oil used was, therefore, 9.75. Multiplied by the constant, 1.5, the volume of oil used becomes 14.625 gallons. In using the curve in Fig. 2 a horizontal line is traced from the point 9.75 at *I* and a vertical line is drawn from the point of intersection of the horizontal line on the diagonal line. The vertical line falls at *E* which corresponds to the 14.625.

The following is data for a typical day's run on one furnace:

Heat No.	Inches. Oil	Gallons. Oil	Brass melted. Pounds
To heat furnace in morning	6.00	9.00	...
First heat..........	10.00	15.00	625
Second heat........	10.00	15.00	630
Third heat.........	9.50	14.25	629
Fourth heat........	10.50	15.75	628
Fifth heat..........	9.75	14.375	630
Sixth heat..........	10.25	15.375	628
Seventh heat......	11.00	16.50	627
Eighth heat.......	10.00	15.00	630
Blow out..........	3.00	4.50	...
		134.750	5,027

134.75 gallons fuel oil required to heat 5,027 pounds brass or 53.6 gallons fuel oil per ton brass melted.



BEARING CAP PATTERN FOR RUSH JOB

Time-Saving Kink for Rush Job

By M. E. Duggan

Patternmakers are called upon occasionally to prepare a pattern in an emergency, when a breakdown occurs and it is necessary to have a new piece made in the shortest time possible. In his haste, the patternmaker may decide upon a form of pattern which will save some time in the pattern shop, but which will cause an unnecessary expenditure of time in the foundry. To save delay, the patternmaker not only must consider the time required to make the pattern, but also the time consumed in making a mold from the pattern. This is particularly true when the patternmaker plans to save time by supplying the foundryman with sweeps instead of a pattern.

A pattern made for a large bearing cap is a good example of how one rush job was handled. Every piece of wood used in making this pattern was cut from a board dressed to 1 inch. The use of standard stock saved considerable time. The two end or binder pieces, *A* and *B*, were cut to the proper size. The filler pieces, *C* and *D*, were first cut to the correct length on the band saw and then cut to width on the rip saw. The pieces were assembled as shown in the accompanying illustration. Instead of being round, the inner and outer surfaces were made of flat sections leaving a wedged-shaped space between the filler pieces shown at *C*.

The natural tendency of patternmakers is to fill these spaces and reduce the irregular surface to a curved plane. This is unnecessary in an emergency, since the molder can fill the spaces with ordinary molding sand and smooth the surface with his slick. In this case the break occurred at 1:45 p. m. and the casting was completed at 4 p. m. The only tools which were used in making the pattern were the band and rip saws.

Do Grinding Wheels Actually Grind?

By Howard W Dunbar

IT HAS been a much debated question from the early use of the grinding wheel up to the present time as to just what occurs when the grinding wheel comes in contact with a piece of steel, cast iron or other hard material, and it probably will be surprising as well as interesting to know that the opinions of almost every one on this subject are correct to a greater or lesser degree.

In the early use of the grinding wheel and grinding machine the operation was nothing more than a polishing one, in which the material removed from the work was worn away by abrasion, friction, polishing, or whatever you may desire to call it. This fact was due to various reasons. Principally however, was the fact that the grinding machine was light, inexpensive and did not provide the proper support for the grinding wheel; and, too, the wheel in itself had not been developed to the high degree of refinement now usually found and always possible in a grinding wheel.

Even today, with good, heavy grinding machines, incorrect wheels, speed of work revolution or speed of wheel are used, which produce just as indifferent results as were always evident by the older methods. However, the reason for these indifferent results today cannot be charged to the grinding machine or grinding wheel, but rather to a lack of knowledge on the part of those responsible for such work for not selecting proper wheels or proper speeds to produce the best results.

Because of these facts, when some people say that grinding is nothing more than the rubbing away of material by abrasion they are correct; when others say that it is a polishing operation they are correct; and when still others say that it is a grinding operation which does not actually remove slivers of metal they are correct. By the ideal conditions, with the right wheel, right work speed, right type of machine, right kind of an operator, the grinding wheel actually cuts the metal and produces chips which resemble in shape and form chips produced by a lathe tool, only they are very much smaller and there are a great many more of them. These are the conditions which the grinding machine engineer always thinks of when speaking of the grinding operation. The object which should be constantly before every grinding operator is to make his wheel act in such a manner as to produce these little chips, because under these conditions the most metal is being removed, the greatest amount of work is being produced, and the machine and wheel are being used at their highest possible efficiency.

In the illustration accompanying this article is reproduced a photomicrograph of chips removed by a grinding wheel operated under the proper conditions.

It is possible with most wheels of average grain and grade to so regulate the work speed, wheel speeds and conditions of grinding as to make the wheel actually produce these little chips. The skill of the operator and his knowledge of the art of grinding play an important part in the amount of work produced and the results accomplished. Today with a wheel 2 inches wide of the grain size commonly used, there are approximately 1,171,000 little cutting particles coming in contact with the work every minute the wheel is revolved at the recommended speeds, and accordingly there is an equal number of little steel chips removed from the work in the same time. If this width of wheel is increased, more and more particles are caused to do their share of the work, and more and more chips will be produced when the wheel is used under correct conditions. It is for this reason alone that the wide wheel is used in cylindrical work.

PHOTOMICROGRAPH OF CHIPS FROM A GRINDING WHEEL

From *Grits and Grinds*, February, 1917. The author, Howard W. Dunbar, is with the Norton Grinding Co., Worcester, Mass.

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Contents

How the Foundry Industry Has Prepared for War 171
History of Nickel Plating for Stove Decoration 175
Leaky Malleable Castings 175
Sensible Flask Equipment for Machine Molding 176
Electric-Arc Welding for Foundry Purposes 179
Chill Cracks in Lathe Beds 182
Systematic Pattern Storage Aids the Foundry 183
Experiments with Permanent Molds 187
Bethlehem Makes Large Iron Mold for Guns 188
Chilled Castings from a Cupola Running Gray Iron 188
Modern Methods of Melting Non-Ferrous Metals 189
Melting Brass in a Gas-Fired Cupola Furnace 189
Melting Practice at the Royal Mint 191
Ideals in Melting Metals 193
Gas as Fuel for Melting Alloys 193
Melting in a Crude-Oil Furnace 194
Electric Heating of Crucibles 194
What is Beryllium? 194
Problems of the Brass Founder 195
Porous Copper Castings 195
Melting Copper in Cupola 195
White Aluminum Alloy 196
Flux for Brass Particles 196
White Metal for Art Work 196
Lining for Melting Furnace 196
Magnalium Castings 196
Mixture to Hold Gasoline 196
Facings for Brass Castings 196
A Study of Inclusions of Alumina in Steel 197
Mixtures for Cylinders 202
Measuring Furnace Oil Without Using a Meter 202
Time-Saving Kink for Rush Job 203
Do Grinding Wheels Actually Grind? 203
Contents 204
A Problem for Foundrymen 204
Trade Outlook 204
Installing a Uniform Cost System in Foundries 206
What the Foundries are Doing 207
New Trade Publications 208

A Problem for Foundrymen

BEFORE many days manufacturers will be forced to realize that the war into which we have entered is to be taken seriously. The nation cannot fulfill its military duty satisfactorily without enlisting the aid of every industry, and the foundry will be called upon to play an important part. Foundrymen who today are willing to sit tight until necessity for action comes, will awake tomorrow to find that short-sightedness has greatly decreased their capacity for doing business for themselves or for the government. Wide-awake leaders in the foundry industry foresee the needs of the future and are making plans to be prepared. They realize, for instance, that the labor problems must be solved. The supply of foundry workers has never been sufficient in the past few years and with the tremendous demand for men in the military departments of the government and in the industries directly engaged in supplying and transporting war materials, there will be a further depletion in the ranks of foundry labor. If we are to profit from the experience of England and France we must take steps to preserve the organization of our foundries. To allow the indiscriminate withdrawal of men from the iron, steel and malleable casting plants of the country would be a mistake almost as disastrous as that which permitted the technically trained men of the allies to rush into the trenches at the first call in Europe. Enlistment from the industrial forces must be accomplished systematically, and according to a preconceived plan which carefully weighs the relative importance of military and industrial strength. The men engaged in the heavy work must be retained, but in the core room, light machine molding, offices, drafting rooms, etc., there is an opportunity to gradually replace men by women as the demand for men makes such action necessary. The problem of maintaining the efficiency of a smooth running foundry organization merits the attention of the leaders of the industry, and under no consideration should the country be allowed to suffer because the casting plants fail in producing their quota of war goods.

Trade Outlook

MUNITIONS work resulting from America's entrance into the war has had little effect upon the foundry industry except that foundrymen are forced harder than ever to meet the demand for castings. Slow deliveries of building materials have prevented many manufacturers from operating new foundries and additions to existing plants until long after the scheduled dates and enlistments coupled with the general scarcity of labor have caused foundrymen to wonder where they will secure men to operate the new units when they are completed. The prices of fuel and iron continue to soar and $50 iron is mentioned as a not-far-distant possibility. No. 2 foundry iron is quoted in the leading trade centers as follows: Pittsburgh, $40.95; Chicago, $39; Cleveland, $39; Buffalo, $45; Birmingham, $33; and Philadelphia, $41. Malleable pig iron is listed at $40.95, Pittsburgh; $39, Chicago, and $45, Buffalo. Lake Superior charcoal iron is selling at $40.25, Chicago. Spot foundry coke is quoted at $9.50 to $10; while coke for second half delivery sells at $8 to $9. Ferro-manganese is held at from $350 to $425.

Bureau of Standards Asks Alloy Information

The United States bureau of standards is making a compilation of the present state of knowledge and practice concerning the numerical values used by engineers and others for the properties of metals and alloys with a view of making generally available the most acceptable values of these constants and also for use as a basis of further experimental investigation. Blanks have been distributed among brass foundrymen, which are to be filled out, giving various chemical and physical properties of the metals or alloys and specific information is desired on the following:

Aluminum and its light alloys with zinc, copper, etc., of stated percentages; nickel, Monel metal and copper-nickel alloys; aluminum bronzes, such as aluminum 7 per cent and copper 93 per cent, and also aluminum 10 per cent and copper 90 per cent, etc.; manganese bronzes, both cast and wrought; phosphor bronzes, such as copper 80 per cent, tin 12 per cent, lead 7 per cent, and phosphorus 1 per cent; Muntz metal, naval brasses, Tobin bronze and brass containing 70 per cent copper and 30 per cent zinc, red and other brasses; bronzes containing copper 90 per cent, tin 10 per cent; copper 88 per cent, tin 10 per cent, zinc 2 per cent; copper 88 per cent, tin 8 per cent, zinc 4 per cent and other modifications with lead and iron added, etc., bearing metals, white metals and other alloys.

The following information is to be furnished to the bureau: Name of metal or alloy; state or condition, such as cast, annealed, hard-drawn, etc.; chemical composition and impurities; density; shrinkage coefficient; tensile strength, yield point and elastic limit in pounds per square inch; elongation in 2 inches, per cent; reduction of area, per cent; Brinell or scleroscope hardness; behavior in compression; frictional coefficient; abrasion resistance; melting range; coefficient of expansion; specific heat; thermal and electrical conductivity; resistance to corrosion; hydraulic properties, etc.

The United Compound Co., Buffalo, manufacturer of core wax and wax vent wire, will move into larger quarters at 228 Elk street, the same city.

The Sullivan Machinery Co., Ltd., has removed its office from Montreal to Toronto. Air compressors, hammer drills and spare parts are carried in stock.

The zinc-mining and zinc-melting industries experienced a year of prosperity in 1916. It is estimated that the recoverable zinc content of ore mined in the United States was 708,000 tons, compared with 605,915 tons in 1916 and 406,959 tons in 1914. The largest district gain was made by the Joplin region, which had an increase of over 40,000 tons.

Personals

Edward Salts, formerly connected with the foundry of the Jeffrey Mfg Co., Columbus, O., is now plant superintendent of the Lewis Foundry & Machine Co., Pittsburgh, with works at Groveton, Pa.

Louis Knapp has resigned as superintendent of the foundry department of the Haskell & Barker Car Co., Inc., Michigan City, Ind., to accept a similar position with the Chicago Malleable Castings Co., Chicago.

H. E. Dennie, formerly located at Salt Lake City, as representative of the Imperial Belting Co., Chicago, has been appointed western manager with headquarters at 525 Market street, San Francisco.

Charles Vickers, formerly associate editor of *The Foundry,* who has been connected with the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., during the past four years, has severed his affiliation with that company.

J. W. Dopp, 1420 Dime Bank building, Detroit, formerly identified with the International Molding Machine Co., Chicago, as Michigan representative, is now handling the line of molding machines and foundry equipment manufactured by Henry E. Pridmore, Chicago.

Oil Residue as a Cupola Fuel

The coke shortage, which has been unusually acute, has compelled foundrymen to resort to many expedients to get out their heats and in addition to the free use of bituminous coal charged with coke in cupolas, many foundrymen have experimented with a crude oil residue which has given unusual results. This residue contains approximately 99 per cent carbon and since it is unusually low in sulphur, 0.025 per cent, it makes an exceedingly desirable fuel for cupola operations. It has been found that owing to the intense heat generated by this residue, the metal becomes unusually hot. It is necessary to charge it with coke, since it will not carry the burden of a cupola charge when used alone. In the extreme west, where coke is unusually high in price, this crude oil residue has been used successfully in foundries for several years.

Pattern Lumber Selection

By E. L. Watson

In the March issue of *The Foundry* an interesting article was published on "The Selection of Pattern Lumber." No one more appreciates the importance of good pattern lumber, even if it is used merely for a master pattern, than the man in charge of the pattern shop. About a year ago I stopped ordering pattern lumber. This was due to the fact that a carload of clear white pine would contain soft and hard lumber, some gummy, some coarse-grained and some fine in grain. The lumber dealer who received the order seemed to consider white pine without knots satisfactory pattern lumber and sent it along. We buy white pine flask lumber in carload lots and I select a sufficient amount of lumber from this to serve my purpose. When the car is delivered I take my pick of the lot and always get No. 1 material. I pick out the close-grained boards with the black knots, which are sent away to dry thoroughly before use. This lumber is particularly desirable for turning large thin shell patterns requiring a soft, sound, even-tempered quality. Also, it is fine for carving. One can always work it up economically with little more waste than clear material and it is pattern lumber in every sense. The saving to the company is large and the economy effected in the pattern shop is considerable.

Trade Notes

Scovell, Wellington & Co., Boston, certified public accountants and industrial engineers, have established a Cleveland office in the Illuminating building under the direction of H. L. Green, resident manager, and V. D. Bierman, associate manager.

The Hoopes Combustion Engineering Corporation, Glens Falls, N. Y., is installing an electric furnace for the manufacture of steel castings. A large extension to the foundry is being built for this department.

The Chicago office of T. P. Kelly & Co., New York, manufacturers of foundry facings and supplies, has been removed to the Boylston building, 333 South Dearborn street. A larger warehouse also has been acquired for the stock of foundry supplies carried by this company in the central west.

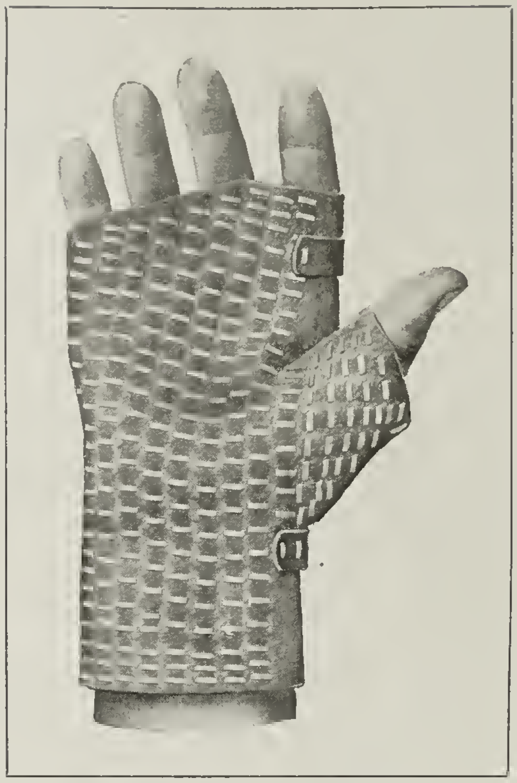
The Julius King Optical Co., New York, has been awarded the Louis Livingston Seaman medal for the year 1916 by the American Museum of Safety. This medal was awarded for "progress and achievement in the promotion of hygiene and the mitigation of occupational disease". This award was based on the Julius King Optical Co.'s efforts in the production of a scientifically correct color scheme for lenses in goggles worn by workmen exposed to the intense glare of arc welding and other metallurgical operations.

Test of Crucible

It is said that 70 consecutive heats of brass were poured from a new type of crucible recently developed by the Lava Crucible Co., Zelienople, Pa., during a recent test in charge of F. T. Aschman, professor of chemistry, University of Pittsburgh. The test, conducted April 13-15, was witnessed by a number of brass and crucible steel manufacturers in the Pittsburgh district.

The analysis of the metal used was: Copper, 68.17 per cent; zinc, 30.16 per cent; iron, 1.05 per cent; lead, 0.11 per cent, and oxygen, 0.35 per cent. The average weight of the metal charged into a commercial No. 60 crucible was 89 pounds. The crucible lost four pounds in weight during the test and weighed 31 pounds after the seventieth heat was poured.

The crucible of the Lava company was developed by Louis DeBats, superintendent of the plant. Since importations of German clay have been shut off by the war, it is interesting to note that the Lava crucible is made entirely from domestic products, including graphite, clay, carborundum and binding materials. The company has completed plans for increasing the capacity of its plant to 2,000 crucibles a week. Officers of the company, which has offices in the First National Bank building, Pittsburgh, are: President, M. E. Moffett; vice president, M. W. Ray; secretary and treasurer, P. L. Berkey.



STEEL REINFORCED LEATHER HANDPAD

A Serviceable Handpad

Owing to the growing scarcity of heavy canvas, old belting and other second-hand materials which were formerly used in making handpads, there has been an increased demand for a scientific and serviceable handpad for use in foundries. A handpad of heavyweight chrome tanned leather reinforced with steel lacings has recently been developed by the Hickory Steel Grip Glove Co., Chicago. A strap and buckle form the adjustment about the wrist, while a leather strap attaches the pad to the top of the hand. As shown in the accompanying illustration, the fingers are left free for use, thus making the pad especially adapted for working with sheet metal. When the hand is closed, the entire palm and fingers are protected.

Installing a Uniform Cost System in Foundries

TO PROMOTE the adoption of a uniform system of foundry cost accounting among its members, the American Foundrymen's Association has outlined a plan of procedure which represents the most comprehensive effort in this line of endeavor that has ever been undertaken by a co-operative body. For many years this organization has had cost committees at work which have presented valuable reports at the annual meetings of this society, but unfortunately a large part of this work has been without practical results owing to the fact that the members, in only few instances, have followed the recommendations made.

To make this work more practical and to facilitate the installation of uniform cost-keeping methods in the plants of the members of this association, it has been decided to provide them with the personal service of a cost expert whose duty it will be to make their existing cost systems conform to the one that is to be adopted. Without the services of a cost accountant to introduce the system, no headway can be made toward uniformity of practice, which is the underlying basis for intelligent estimating among competing companies. Since the American Foundrymen's Association, due to its low cost of membership, is without means to carry on this special work, it was decided to raise a fund by subscription among those who desire to participate in the benefits to be derived from this undertaking. The plan will enable foundrymen to obtain a cost accounting system at a nominal cost, which will be representative of the latest and best practice in cost-keeping methods.

Cost is Nominal

Productive labor is a good measure of the value of the business transacted by a foundry and, therefore, the expense of this undertaking will be pro-rated on the basis of the number of molders and coremakers employed. The schedule of charges that will apply follow: Foundries employing up to 40 molders and coremakers, $50; from 40 to 200 molders and coremakers, $1.25 for each molder and coremaker employed; for plants employing more than 200 molders and coremakers a flat charge of $250 will be made. Since additional traveling expense will be involved in the installation of the system outside of the industrial centers of the United States and Canada, an extra charge will be made for this service west of the Mississippi river, south of the Ohio river and outside of the Province of Ontario, in Canada.

Payments are to be made on the following basis: Twenty-five per cent when subscribing to this special fund; 25 per cent upon the receipt of the book containing the uniform cost system; 25 per cent after the system has been installed by the cost expert and the remaining 25 per cent after the subscriber has received from the cost accountant a written report covering the system in use, with suggestions to make it conform to the uniform method to be adopted.

To carry on this work, the cost committee of the American Foundrymen's Association has engaged the services of C. E. Knoeppel & Co., New York, industrial engineers and cost accountants. Data are now being gathered preparatory to the compilation of a uniform system of cost-keeping for foundries which can be adapted to shops specializing in the manufacture of gray or malleable iron, or steel castings. The problems of the foundry which is a department of a manufacturing plant and produces no castings for the trade will e considered and provision also will e made for specialty, light and eavy work shops.

When the uniform cost system has een ratified by the cost committee, will be printed in pamphlet form nd will be distributed among all f the subscribers. As soon as posible thereafter, cost experts in the mploy of C. E. Knoeppel & Co. will isit each one of the plants of the ubscribers and will point out the eatures of the cost system and will id in its installation. This personal isit will be followed by a written eport by the cost expert who will etail every step to be followed in he introduction and use of this sysem. For a reasonable time thereafter, he advice of C. E. Knoeppel & Co. an be had by correspondence without dditional cost to any of the subcribers.

Subscribers Must Be Members

Subscribers to this fund are limited o the membership of the American Foundrymen's Association, but foundries not so enrolled can derive the benefit of this great work by becoming members of this organization.

Furthermore, only subscribers to this special fund will receive a copy of the uniform cost system and the services of C. E. Knoeppel & Co., membership in the American Foundrymen's Association alone not entitling those so enrolled to participate in the cost accounting work.

Favorable replies already have been received from 217 members of this organization in the United States and Canada, and 51 have forwarded their subscriptions. This is sufficient assurance that the plan can be carried to a successful conclusion and it marks the beginning of the greatest uniform cost campaign ever undertaken in a single industry.

The members of the cost committee who conceived this undertaking follow: B. D. Fuller, chairman, Westinghouse Electric & Mfg. Co., Cleveland; H. J. Koch, Fort Pitt Steel Casting Co., McKeesport, Pa., J. Roy Tanner, Pittsburgh Valve Foundry & Construction Co., Pittsburgh; C. R. Messinger, Sivyer Steel Casting Co., Milwaukee, and A. O. Backert, secretary, Twelfth and Chestnut streets, Cleveland.

The McGraw and Hill publishing companies, New York, have been consolidated under the corporate name of the McGraw-Hill Publishing Co., Inc., which has acquired all of the properties and interests of the two constituents, including the following technical journals: *Electrical World, Electrical Railway Journal, Electrical Merchandising, Engineering Record, Metallurgical and Chemical Engineering, The Contractor, American Machinist, Power, Engineering News, Engineering and Mining Journal* and *Coal Age. The Engineering News* and *The Engineering Record* have been consolidated under the name *"Engineering News-Record"*, with Charles Whiting Baker, former editor of *Engineering News,* as editor-in-chief. James H. McGraw is the president of the new company, Arthur J. Baldwin, president of the Hill Publishing Co., vice president and treasurer and E. J. Mehren, vice president and general manager.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Sav-A-Life Fender Co., Ashtabula, O., ontemplates the erection of a foundry.

The Hammer-Bray Co., Center street, Oakand, Cal., will erect a one-story foundry.

The Dearborn Foundry Co., Chicago, has een incorporated with $10,000 capital, by C. . Fargo, D. D. English and L. B. Fargo.

The Weatherly Foundry & Machine Co., Veatherly, Pa., will make extensions to its lant.

The McCairns Foundry Co., Connellsville, a., will build a one-story, 60 x 65-foot foundry addition at a cost of $10,000.

Edgar T. Ward & Sons, Boston, have purhased a site on Old Colony avenue for a oundry.

The Smith Gas Engine Co., Dayton, O., ontemplates erecting a two-story office buildng, a foundry and a machine shop.

A one-story addition, to cost $20,000, will e erected to the plant of the Stevens Foundry & Machine Co., New Orleans.

The Elmira Transmission Co., Elmira, Ont., Can., will build dry kilns, a foundry and a nachine shop.

Contracts have been awarded for the erecion of a large addition to the plant of the Osborne Casting Co., Racine, Wis.

The Industrial Machine Co., Pottstown, Pa., ontemplates the erection of a foundry, 50 x 30 feet.

A contract has been awarded for a 60 x 00-foot foundry to be erected by the Turner-Fricke Gas Engine Co., Sharon, Pa.

The Singer Mfg. Co., Elizabeth, N. J., will build a one-story foundry, 200 feet square, at a cost of $60,000.

A $12,000 foundry will be erected on Cherry street, Toronto, Ont., for the Queen City Foundry Co.

The Davis Mfg. Co., Milwaukee, will build a foundry, 150 x 300 feet, of brick, steel and concrete construction.

The Syracuse Malleable Iron Works, Syracuse, N. Y., has awarded the contract for a $15,000, 87 x 183-foot addition to its foundry.

The Pennsylvania lines west will build a 1-story, 50 x 50-foot addition to its brass foundry at Allegheny, Pa.

The Spramotor Co., London, Ont., Can., will build a foundry and machine shop at St. Thomas, Ont., at a cost of $100,000.

The Ohio Steel Foundry Co., Lima, O., has purchased the Blackwood Steel Foundry Co., Springfield, O., and will continue to operate it.

The Whitehead & Kales Iron Works, Detroit, will build a foundry and machine shop, 74 x 272 and 62 x 112 feet, respectively.

Plans have been prepared for the erection of a 72 x 100-foot addition to the foundry of the Independent Stove Co., Owosso, Mich.

The Wisconsin Farm Implement Co., Beloit, Wis., contemplates the erection of a 40 x 75-foot addition to its foundry.

The Joseph Pedrick Foundry Co., Camden, N. J., will build a 75 x 78-foot plant for the manufacture of cast iron boilers.

The Louisville Car & Foundry Co., Louisville, Ky., has been incorporated with a capital stock of $10,900 by C. H., Henry and Charles Schimpeler.

The Edgewater Foundry Co., Edgewater, N. J., has been incorporated with $10,000 capital, by Joseph Fuchs, F. Butzhah and A. W. Brain.

The Montrose Improvement Co., Thirteenth and Berry streets, Brooklyn, will build a foundry of brick and steel construction, one and two stories, 80 x 180 feet.

Plans are being prepared for a foundry and other additions to the plant of the Rock Island Mfg. Co., Rock Island, Ill., which will cost $30,000.

The Vancouver Engineering Works, Vancouver, B. C., Can., has been incorporated to conduct a general foundry and machine shop business with $1,000,000 capital.

C. S. Brown, Fred Bizzantz, J. M. Morgan, Carl C. Kesler and W. J. Richie have incorporated the Chalmers Mfg. Co., Lima, O., with a capital stock of $60,000. A foundry will be operated.

The Flockhart Ring Casting Co., Newark, N. J., has been incorporated to engage in the manufacture of piston rings with $30,000 capital, by James Flockhart, D. Sensano and others.

The Blewett Harvester Co., Pendleton, Ore., plans the erection of a foundry. The Walker Foundry & Machine Co., Braddock, Pa., will build a foundry addition, 36 x 40 feet and a machine shop, 124 x 166 feet.

The Aetna Foundry & Machine Co., Warren, O., has been taken over by W. W. Woodruff, of the Jeffery Mfg. Co.; Robert L. McCarroll, of the United Coal Co., and J. McClain, of the McClain Mining Co., all of

Pittsburgh. The plant will continue to make castings and tin plate machinery and will be enlarged shortly.

The Cleveland Aluminum Castings Co., 1386 East Fortieth street, Cleveland, has purchased a site, 50 x 140 feet, adjoining its present property, on which it will build an aluminum foundry.

The Indianapolis Castings Co., Indianapolis, has been incorporated to take over the Indianapolis Foundry Co. The new company is capitalized at $175,000 by Frank W. Lewis, Charles O. Roember and John Wallace.

The Bradley Machine Co., Middletown, N. Y., has been incorporated to operate a foundry and machine shop. The company is capitalized at $107,500 by E. N. Oakes, J. M. Bright and T. Watts, 4 East Main street.

The Columbia Malleable Casting Co., New York City, has been incorporated with $50,000 capital. F. F. Gearn, W. F. Wood and F. M. Clute, 100 Broadway, New York, are the incorporators.

The B. C. Co., Revere, Mass., has been incorporated to engage in the foundry business with a capital stock of $5,000. Henry A. Buzzell is president and Edward H. Tibbets, treasurer.

H. Kramer, 720 South Canal street, Chicago, will build a foundry, 75 x 125 feet; a warehouse, 75 x 125 feet and a crushing room, 40 x 75 feet. The estimated cost is $60,000.

Thomas J. Finn, Waterbury, Conn., will erect a $50,000 iron foundry on a site which he recently purchased at Worcester, Mass. The plant will probably be operated under the name of the Worcester Foundry Co.

The Tristate Foundry & Machine Co., Wellsburg, W. Va., has been incorporated with a capital stock of $50,000. The incorporators are M. J. Konold, E. D. Mason, E. A. Johnson, E. R. Wendemuth, Pittsburgh, and Alex McInnes, Wellsburg, W. Va.

E. G. Bosworth and C. E. Ard have organized the Bosworth-Ard Machine & Foundry Co. and will remodel the plant of Stickney & Levi, Anniston, Ala., into a general foundry and machine shop for the manufacture of gray iron, semi-steel and brass castings.

The Aluminum Goods Mfg. Co., Manitowoc, Wis., will erect a new plant at Newark, N. J., which will cost approximately $350,000. The building will be six stories high, 75 x 375 feet, of reinforced concrete, steel and brick construction.

The name of the Southern Illinois Machine & Foundry Co., Murphysboro, Ill., has been changed to the Egyptian Iron Works. The company contemplates the erection of a foundry and car shop for the manufacture of mining cars and other mining equipment.

J. H. McNary, formerly general superintendent of the Magee Furnace Co., Taunton, Mass., will erect a foundry, two stories high and 60 feet in length, at Chelsea, Mass. He has purchased the business of the Dighton Furnace Co., Dighton, Mass., and will remove it to the new plant when completed.

The James A. Brady Foundry Co., Chicago, has purchased a site, 266 x 449 feet, at Forty-fifth street and Western avenue. The company will erect a new plant, including a foundry and office building, 150 x 360 feet and a cleaning building, 90 x 135 feet. The estimated cost of the plant is $300,000.

Emil Mueller, formerly manager of the Cedar Grove Foundry Co., Cedar Grove, Wis., has organized the Mueller Foundry Co., of Cedarburg, Wis. with a capital stock of $6,000. The company will operate the former plant of the Cedarburg Foundry Co., now owned by John Lauterbach, who, with Oscar J. Hurth are the owners of the new concern. The Cedarburg foundry was idle for some time until early last fall, when it was leased by outside interests and operated only a few months.

The Pyott Co., 955 Carroll avenue, Chicago, manufacturer of cast iron pulleys, has purchased the plant of the W. A. Jones Foundry & Machine Co., North avenue and Noble street, Chicago, including a machine shop, power house, foundry and other buildings. The site embraces about 65,000 square feet of ground.

The capital stock of the National Steel Casting Co., New Cumberland, W. Va., has been increased from $100,000 to $300,000 and it has been decided to install an additional 25-ton basic open-hearth furnace. At present one unit of this size is in operation. This company manufactures castings for rolling mill and railroad work and also does an e tensive jobbing business.

The Lipman Car & Refrigerator Co., B loit, Wis., manufacturer of refrigerating uni for railroad cars, will erect a plant having capacity for equipping 12,000 cars annuall The plant will include five buildings, 40 250 feet, with double tracks; two building 60 x 300 feet, a foundry, machine shop, woo and sheet metal-working shops and oth structures.

Negotiations are under way for the locati of a malleable iron foundry at Louisville, K Tampton Aubuchon, general manager of th Louisville Industrial Foundation, is endeavo ing to interest manufacturers of malleab iron in the location of a plant at Louisvil and if this is not successful, local capital wi be employed to develop the industry.

NEW TRADE PUBLICATIONS

DRILLING MACHINES. — The Langelier Manufacturing Co., Providence, R. I., is distributing an eight-page folder devoted to belt-driven ball-bearing drilling machines. Each type of machine is illustrated and described by complete specifications. The standard equipment of these machines includes foot feed in addition to hand feed. One belt and one hole depth gage is shipped with each machine. In the two spindle type drill each spindle may be run or stopped independently of the other. The drills are equipped with automatic oil feed with foot controlled automatic shut-off.

BELT-DRIVEN ALTERNATORS. — An eight-page bulletin, issued by the General Electric Co., Schenectady, N. Y., is devoted to belt-driven alternators, built in sizes from 30 to 240 kilowatts. These generators are designed for both power and lighting service and can be furnished with either direct-connected or belted exciters. All pole pieces are punched to receive a squirrel cage winding, so that at any future time the machine can be changed to a synchronous motor or synchronous condenser by the simple addition of this winding, which can be assembled readily by any station operator. Detailed views of the machine are included, with tables showing complete ratings.

PNEUMATIC TOOLS. — The Independent Pneumatic Tool Co., Chicago, recently issued a catalog devoted to the company's complete line of pneumatic tools and electric drills. It is said that piston air drills are now equipped with pressed vanadium steel connecting rods and pistons. Concise descriptions accompany the illustration of each tool and each individual part. In the electric drills the windings are all enclosed; the countershaft and spindle are supported on roller bearings as they run at a slower speed. The large size drills have large bronze plain bearings at the lower end of the spindles. This construction provides for side thrusts placed upon them by the forcing of the drills or reamers through the work.

CORKBOARD ISOLATION. — A comprehensive booklet devoted to a description of the use and application of corkboard as a sound deadener was recently issued by the Armstrong Cork & Insulation Co., Pittsburgh. Noise and vibrations have long been recognized as undesirable but little has been done in past years with the object of reducing or eliminating them except in hospitals, hotels, etc. Noise is the direct result of brations and in consequence can only be eli inated in the same proportion as the vibr tions are eliminated. There are two way according to the Armstrong company, in whi this may be accomplished: First, by ancho ing the machine to a foundation too massi to be set in motion by the vibrations ge erated by its operation; second, by isolati the machinery—that is by placing it upon material of such structure that the vibratio will not readily pass through it, but will absorbed. Corkboard is said to fulfill the quirements of the alternative.

HAND TRAVELING CRANES. — T Brown Hoisting Machinery Co., Clevelar has issued a catalog containing 36 pag which is devoted to overhead hand traveli cranes. Its construction permits it to used in very limited head room and it co sists of a single I-beam supported at ea end on a cast steel truck frame. The I-be is of standard size, the lower flange servi as a track for the trolley with the load. T truck frame is a single steel casting of lig construction with ample strength for the cra capacity. The I-beam rests on two plar surfaces at the center of the truck frame, ing bolted to the truck frame at the top a also is held in place by a dowel on truck frame which fits into a small rec on the bottom side of the small flange of I-beam. The truck frame is supported two truck wheels with a bearing on ea side of the wheel. All standard cranes fr one-fourth to one ton capacity inclusive, w spans not exceeding 11 feet, have no tra ing mechanism. These cranes, however, propelled easily along the track by push or pulling on the load. The larger capac cranes are equipped with hand-traveling ch and sprocket wheel. By pulling on the ha chain the crane is propelled along the r way. The largest capacity cranes are fit with traveling gears which reduce the amo of pull required on the hand-traveling ch necessary to travel the crane. Also, cranes can be equipped with a travel mo for propelling it along the track, being c trolled from the floor by means of pend cords. The catalog contains a list of pri of cranes of various sizes, details of th construction and a large number of insta tion views showing the application of th cranes to foundry and industrial plant op ations.

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How We May Conserve Our Metal Resources

Designers of Non-Ferrous Metal Parts Should Aid in This Movement and They Will Find a Willing Ally in the Brass Foundryman

By Charles Vickers

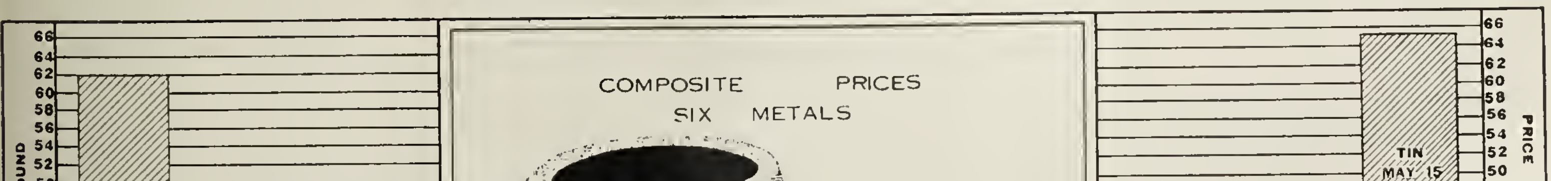
CONSTANTLY advancing prices for non-ferrous metals makes necessary the practice of their conservation today. This should receive the immediate attention of designing engineers, patternmakers and foundrymen and every effort should be made to reduce the weight of cast parts to the minimum allowable by safety and strength, and their substitution by iron and steel wherever possible.

Since the beginning of the war in 1914, the demand for non-ferrous metals has increased tremendously and prices have more than kept pace with the consumptive increment. A further increase in their use for munitions for our government has followed our entry into the war and with requirements greatly in excess of production, still higher prices are anticipated. For this reason conservation should be practiced in all commercial lines in which non-ferrous metals play a prominent part.

The accompanying chart graphically shows the increase in the prices of the six most widely used metals and compares the quotations of July 1, 1914, and May 15, 1917. It will be noted that aluminum has increased 360 per cent; antimony, 370 per cent; copper, 234 per cent; lead, 250 per cent; tin, 217 per cent, and zinc, 185 per cent. The composite price of these six metals had declined to 12.72 cents on July 1, 1914, against 33.75 cents on May 15, 1917, or an increase of 265 per cent. Never before in the history of the metal industry have prices soared to such heights in such a comparatively short time, and the indications are that the peaks have not yet been attained.

The non-ferrous metals that are most serviceable include aluminum, antimony, copper, lead, tin and zinc, and nickel follows in the order named. Without these metals, our present complex civilization would be impossible and their importance scarcely is secondary to that of food-stuffs, iron and coal. The available supply of these metals is steadily diminishing since they are lost by volatilization in melting operations and by attrition in service. It is conceivable, therefore, that a time may come when the resources of these metals will be exhausted, and while this may appear to be far-distant, nevertheless it is essential that this should be postponed as far as possible by the adoption of methods which will tend to eliminate waste.

The accompanying table contains the highest and lowest prices attained by these metals from 1900 to April of this



HOW THE PRICES OF NON-FERROUS METALS HAVE CLIMBED DURING THE WAR PERIOD, WITH A GRAPH OF THE COMPOSITE PRICES OF SIX METALS, MAY 15, THIS YEAR AND JULY 1, 1914 year. It will be noted that the price of aluminum was fairly constant until 1906 when a sharp advance occurred. This was maintained during the following two years, after which an era of comparatively low prices existed until the present war boom set in. Antimony likewise enjoyed a period of prosperity from 1905 to 1907, with a period of depression for four years, after which it recovered with a sudden jump to the present abnormal basis. Copper, lead, tin and zinc each have a history similar to aluminum and antimony, as the same causes that operate to affect the price of one metal of the non-ferrous group affects them all, and while the present level of values cannot be considered to be permanent, it is doubtful whether there ever will be a return to the comparatively low prices of former years.

In the following table, non-ferrous metal prices prevailing on July 1, 1914, and May 15, 1917, are compared and the per cent of increase is noted. The composite prices of these six metals also are included:

Comparison of Non-Ferrous Metal Prices, July 1, 1914 and May 15, 1917.

	July 1, 1914. cents.	May 15, 1917. cents.	Per cent increase.
Aluminum	17.25	62.00	360
Antimony	6.75	25.00	370
Copper	13.25	31.00	234
Lead	3.80	9.50	250
Tin	30.30	65.75	217
Zinc	5.00	9.25	185
Composite Prices of Six Metals.			
	12.72	33.75	265

Aluminum

Aluminum is the first metal on our list to receive consideration from a conservation standpoint. There is no need for the sparing use of this metal for fear of exhaustion of supply, since cost is the all-important factor in this case. Aluminum is one of the most abundant elements on the surface of the earth; in combination with oxygen and silicon, it occurs in enormous quantities in rocks, soils and common minerals. It is destined to play an important part in the history of the world, since by its extended use the resources of all other non-ferrous metals can be husbanded. Its production will increase until it ranks with iron and steel and its price will decline until it can be applied to uses undreamed of now. At present aluminum is being extracted only from its richest ores, thus paralleling the history of most other metals, and its production is hampered by the fact that the deposits of these ores are limited and can be controlled to better advantage than would be the case if aluminum were being obtained from kaolin, or other clays. The source of the aluminum, utilized at present, is bauxite which has to undergo a process of purification before the metal can be obtained therefrom. This is due to the fact that the reduced aluminum otherwise would contain all the impurities that existed in the material from which it was extracted; therefore, if the bauxite were not first purified, the aluminum obtained therefrom would be an alloy of aluminum, iron and silicon, in varying proportions. Such an alloy would be of no use commercially because there is no method of separating the aluminum from the iron and silicon. The purification of the raw material is a considerable item of expense connected with the production of aluminum, therefore, it is highly desirable that improved methods be discovered and utilized, otherwise it is not probable that the price of this metal ever will decline much below 20 cents per pound. The production of aluminum in the future probably will be closely associated with the fixation of atmospheric nitrogen. The Serpek process, utilized to a limited extent, purifies bauxite by first converting it into aluminum nitride, from whic nitrogen products are obtained, an finally, pure alumina which is the starting point of pure aluminum.

Smelting Processes

Unfortunately this process also utilize the richest ore of aluminum, and as this method of purification, even with th advantage of the nitrogen by-product is more costly than the usual method, i has not been adopted generally. Another process, however, appears promising which utilizes kaolins to first mak a siliceous aluminum. It then passes th alloy through a process of purificatio that separates the silicon as metal, an the aluminum as nitride, and from th latter nitrogen products and pure alumina are obtained, the last product bein pure aluminum. It will be noted, therefore, that the day of cheap aluminu undoubtedly is coming, but in the meantime we are concerned more with its present cost and are interested in methods of conserving the metal, by practicing economies whenever this is possible.

There is no great opportunity of conserving aluminum by re-designing patterns, as the metal or its alloys is not used in castings where electrical conductivity is essential, as in the case of copper where it frequently happens that the sectional area of the castings is much greater than strength would demand, or what would be required if the conductivity of the copper were not injuriously affected by the impurities introduced by casting methods.

The point where the greatest saving of aluminum can be effected is in the operation of melting the metal or its alloys, and especially is this the case in melting scrap metals, turnings or other forms of finely divided material. If this operation is not conducted skill-

High and Low Prices of Non-Ferrous Metals, 1900 to April, 1917, in Cents Per Pound

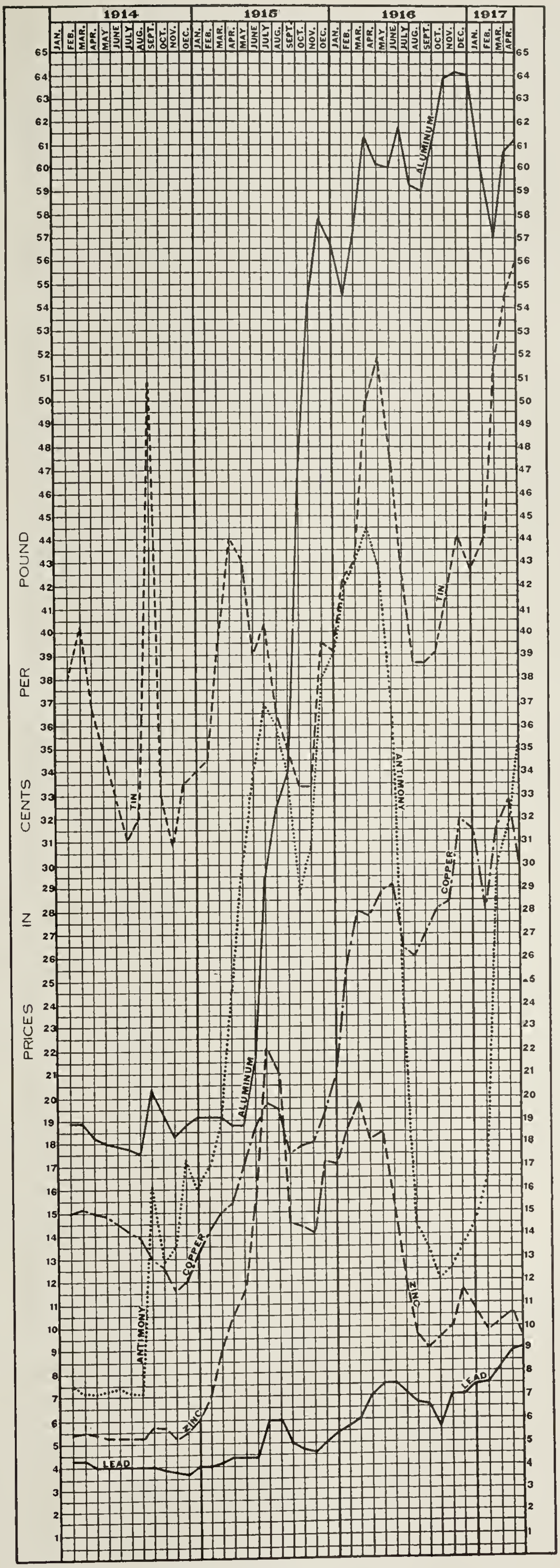
Year.	Aluminum.		Antimony.		Copper.		Lead.		Tin.		Zinc.	
	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.	High.	Low.
1900........................	33.00	33.00	11.00	9.75	17.25	16.00	4.80	3.50	32.50	25.25	4.75	3.50
1901........................	33.00	33.00	10.62	10.12	17.25	15.00	4.40	4.25	28.75	24.75	4.80	3.75
1902........................	33.00	33.00	10.50	9.00	14.50	12.12	4.00	4.00	30.50	24.75	5.50	4.00
1903........................	33.00	33.00	9.00	7.00	15.25	12.00	4.75	4.00	30.50	26.00	6.25	4.75
1904........................	33.00	33.00	9.60	7.00	15.25	12.25	4.50	4.12	29.80	26.50	6.00	4.75
1905........................	33.00	33.00	16.40	8.10	19.25	15.00	5.50	4.50	36.50	29.80	6.25	5.25
1906........................	38.00	33.00	26.90	14.50	24.50	18.50	6.00	5.50	43.75	36.50	7.00	6.00
1907........................	48.00	38.00	26.00	9.50	26.75	13.50	6.12	4.00	43.60	28.00	7.25	4.50
1908........................	38.00	25.00	9.60	8.10	14.50	12.75	5.25	3.75	32.25	27.75	5.25	4.25
1909........................	25.00	22.50	8.75	8.00	14.50	12.80	4.75	4.00	33.50	28.50	6.50	4.75
1910........................	24.00	22.00	8.75	7.75	14.00	13.12	5.00	4.50	39.50	32.50	6.25	5.25
1911........................	22.50	18.75	9.60	7.90	14.12½	12.25	4.62	4.50	46.50	38.75	6.75	5.50
1912........................	27.00	18.75	10.55	7.10	17.75	14.00	5.25	4.12	50.50	42.75	7.75	6.50
1913........................	27.00	19.00	10.00	7.50	17.50	14.75	5.00	4.25	50.75	37.50	7.25	5.00
1914........................	20.50	17.50	17.40	7.10	15.00	11.36	4.25	3.75	50.75	30.50	6.00	5.00
1915........................	60.00	19.00	41.00	16.50	21.50	13.00	6.00	4.00	49.00	33.00	22.62	6.00
1916........................	66.00	55.00	44.50	11.25	34.50	23.75	8.00	5.90	56.00	38.40	22.00	8.75

High and Low Prices by Months, 1917

January	62.00	57.00	26.50	14.20	29.60	26.70	8.00	7.50	46.00	42.60	10.90	9.00
February	58.00	56.00	32.50	25.00	34.00	28.50	8.50	8.00	56.00	49.20	10.70	9.50
March	61.50	58.00	35.00	28.50	33.33	31.50	9.00	8.50	56.50	51.80	10.80	10.50
April	62.00	60.50	36.00	35.00	31.50	28.00	9.00	9.00	59.00	54.30	10.50	8.80

fully the loss will be enormous, while with intelligent handling it is no greater than in the case of other metals. In running down sheet material that is more or less corroded, the loss will be higher than in the use of clean turnings, because the decomposed metal cannot be recovered, but goes to the dross. In melting, the same general methods should be applied to all forms of scrap aluminum, and therefore, a description of a satisfactory method of melting turnings will be given to illustrate the point.

In melting aluminum turnings it is not advisable to use such fluxes as cryolite or calcium fluoride, and as it is highly desirable that the metal be kept away from contact with carbon, the crucible should be given an internal coating of fireclay. The fireclay should be of good grade, passed dry through a fine screen and mixed with water containing silicate of soda. It can be painted onto the crucible in the form of a creamy wash after which it must be allowed to dry slowly to avoid blistering the wash. The importance of keeping the aluminum away from carbon cannot be emphasized too strongly. The crucible should be allowed to reach a red heat before the aulminum turnings are charged. In charging, it is filled with the turnings, after which the furnace should be closed until a melting heat is attained, and after the lapse of sufficient time to allow this stage to be reached, the furnace should be opened and the metal stirred. It will be found to be liquid, but mushy, and additional turnings should be charged. This process should be repeated until the crucible is filled with metal to a point about 1½ inches below the top. The temperature of the metal sholud be below red, and there is little doubt but that it will be mushy, not fluid. This is the time to use zinc chloride; a small piece of this fused material, about the size of a walnut, is tossed onto the surface of the molten aluminum and the latter is stirred vigirously. A reaction will occur, leaving the metal fluid and the dross will rise to the top. Concerntrate attention on the dross and skim it off immediately, either by removing the crucible and skimming in the usual manner, or while the metal is in the furnace. This can be accomplished by using a wide piece of band iron suitably curved at the end. The metal is then ingoted, and if the turnings were reasonably clean and the operation carefully conducted, a recovery of 95 per cent of alminum, or more should be obtained.



UPWARD MOVEMENT OF LEAD, ZINC, COPPER, ALUMINUM, TIN AND ANTIMONY, SINCE 1913, CLEARLY INDICATED

After the use of zinc chloride, if the dross is left on the metal, the nitride will begin to form, first as an incandescent area next to the crucible which will spread rapidly and take up the metal to form nitride and oxide until the crucible is filled with an intensely heated, glowing mass of the two. This means a heavy loss of aluminum, in fact all the aluminum can be lost in this manner by occasionally skimming off the dross to expose the metal which will be heated strongly by the reaction, and as quick as the air gets to the hot metal a further conversion will occur. The reason why carbon should be excluded is that it strongly favors this reaction thereby causing loss of aluminum. The zinc chloride acts as a catalyzer converting aluminum to nitride and oxide; therefore, it is imperative that it be used sparingly and after having been added, its effect should be neutralized by the removal of the dross before it reaches a temperature favorable to further change. Aluminum never should be melted in a furnace in which the products of combustion are driven by a blast so as to converge and pass through an opening centered over the crucible. As the metal is melted without a cover, the rapidly moving and highly heated gases are in excellent condition for entering into reactions with this chemically active metal.

Antimony never attracted much attention before the recent era of high prices and no attempts were made to substitute other metals for it until the war placed it in the limelight; then much research work was undertaken to discover substitutes. There is no substitute for antimony, as this metal fills a niche of its own. As a hardening agent for lead it is unexcelled and no other element can take its place. The alkali and alkaline earth metals have been tried for the latter purpose, but are objectionable because they are not permanent. Sodium, calcium, strontium and barium, all alloy with lead and harden it, and relatively small percentages have a profound effect in this way, but sodium, when used in as small quantities as 1 per cent with lead promotes the formation of an external coating of sodium hydroxide, and with higher percentages the alloy is deliquescent when exposed to the atmosphere. With still higher percentages of sodium, lead forms the alloy known as hydrone, which has to be kept in air-tight receptacles, and finds application as a means of obtaining hydrogen, owing to the property it possesses of decomposing water. Calcium, and its sister metals of the alkaline earths, when alloyed with lead, form alloys more stable than is the case with sodium, but they will not stand remelting without loss of the hardening element; consequently, after remelting a few times, and even in one melt if the lead is overheated, the hardening element has disappeared and the lead arrives at the stage from which it started, namely, pure lead. From a conservation standpoint there are few suggestions that may be offered regarding antimony. We will have to use it while we have it and when the supply is exhausted, if this ever happens, we will have to try to get along without it.

Copper is one of the metals on which conservation should be practiced as we are now producing and using more than ever before. In fact it is being used prodigally, even wastefully in spite of its cost, and there is not a shadow of a doubt but that great economy in the use of this metal would result from improved methods of manufacture if applied judiciously to the making of castings for electrical purposes.

Casting Copper

Copper always has been regarded as an obstinate metal to cast and in this property it differs greatly from some of its alloys. A few copper alloys retain all of the bad features of the parent metal with a few added troubles of their own, as for instance, aluminum-bronze and manganese-bronze, but the common alloys are quite easy to cast. The great difficulty encountered in making copper castings is to overcome porosity as the pure metal cannot be poured in a sand mold with the production of sound castings by a simple melting process no matter how the latter may be carried out. For instance, copper has been melted in a muffle, heated electrically and carefully sealed after an atmosphere of carbon monoxide had been created in the muffle by means of a little charcoal packed between the sides of the crucible and the muffle. Under these conditions several heats of 10 kilograms each were made with identical results. In each case the surface of the molten copper was protected by a covering of fine charcoal and this cover was retained while the crucible was being transferred from the furnace to the molds. In each case the resulting castings were porous, although not nearly so honeycombed as they would have been if the copper had been melted in fuel-fired furnace. The holes in the electrically-melted metal were so fine they could scarcely be detected by the naked eye, and when the copper was poured, the pouring head and risers bulged so slightly it was scarcely noticeable. The castings were nearly sound, but fell short of perfection, and therefore, were unsatisfactory. The experiment proved that copper cannot be melted and cast into sound castings without some treatment calculated to remove the absorbed gases. In the case just outlined a minute amount of any suitable deoxidizing agent would have insured sound castings. These, because of the small amount of impurity added to attain this end, would have possessed the property of high electrical conductivity. Such a method of melting, therefore, possesses important advantages over the usual processes.

Avoiding Porosity

When copper is melted in a combustion furnace, regardless of how carefully it may be protected from the gases that are formed therein, it is always necessary to add some element, such as silicon, zinc, magnesium or phosphorous to remove the gases that cause porosity, but the difficulty is to add just the proper amount to accomplish the desired result and leave only a trace of the impurity in the copper. This difficulty is so great that it is impractical to attempt to attain this result and at the same time adhere to the ordinary methods of melting and casting the copper. There is no way of determining exactly how much oxide, oxygen, sulphur or gaseous bodies the copper may contain as the amount of these undesirable impurities will vary with every melt. It is necessary, therefore, to add an excess of the deoxidizing agent with the result that the metal is so impure that its electrical conductivity may be reduced to 60 per cent, or even 30 per cent of that of pure copper.

Assuming for the purposes of illustration that the conductivity of the copper is reduced to 50 per cent of that of pure copper, it readily will be realized what effect this would have on any electrical installation in which copper castings were used as conductors. It would require double the amount of copper theoretically necessary to carry the load, and in order to carry the extra and useless weight of copper required, the apparatus to which it was attached would have to be built twice as strong as necessary.

Practical Methods of Casting

The subject of deoxidizers and their application to copper for casting purposes is most complex and cannot be treated fully here, but will be discussed in a subsequent article. The discovery and utilization of practical methods of casting pure copper would effect a great saving in the use of this indispensable red metal. It likewise would mean an important saving in the cost of electrical installations requiring the use of such castings and therefore, is desirable also from a monetary point of view. The demand for improvements in methods of casting copper will come, of course, from users who require such parts, but it should be pointed out that if these consumers expect to derive all the benefits from these savings, there will be no inducement to foundrymen to apply improved methods.

Outside of the electrical field copper castings are used because of their special properties, such as for blast and other furnace tuyeres where copper is used on account of its high heat conducting qualities. For this line of work no saving of metal by paring the patterns is possible, and therefore, the field for improvement is too meager to be a subject for consideration.

When we turn to the alloys of copper we find that notable economies have already been effected by the substitution of iron and steel for brass. This has been rendered possible by the application of enamels and so-called enamel paints to iron and steel surfaces thereby producing a satisfactory substitute for brass where the latter is used solely for its ornamental value. However, the competition of iron and steel with brass has made no perceptible impression on the latter industry, and probably has passed without notice except by those directly interested. New avenues for the sale of brass, bronze and copper castings have been developed continually in the past decade. The automobile and motor truck have created an immense demand for non-ferrous metal castings. Electric welding processes have stimulated the demand for copper castings, and the same is true of the extended application of the electric furnace in the operation of which large quantities of copper and bronze water-cooled electrode holders and cast copper terminals are used.

Another promising industry, from the point of view of the brass founder, has been created by the advent of the diesel engine, in the construction of which a large amount of non-ferrous metals is required.

The demand created by the automobile, the diesel engine and other modern inventions is more particularly for castings of definite chemical composition and high physical properties. The blunderbuss method of making alloyed metals, which consists of throwing into a crucible, or open-flame furnace a little of this, that, and the other kind of scrap, melting and stirring it together, with an eye to careful economy of tin, and openhearted generosity in regard to lead and zinc, will not suffice in these latter-day industries. The metal must be made to conform to a specified formula and test bars for large sections, must be attached to the castings. The castings used on automobiles generally are small and consist largely of alloys suitable for bearing purposes. The worm gears for some auto trucks are desirable castings to make as they may weigh from 60 to nearly 100 pounds. The alloy used is phosphor-bronze, containing substantially 11 per cent of tin with sufficient phosphorous to make the alloy machine easily. These castings must be made in chills to prevent segregation of the various copper-tin compounds formed as a result of slow cooling, and to reduce the size of the crystals by allowing no time for growth. The gears are merely rings with straight sides, and the teeth are cut by special machines being shaped to fit the circle of the worm on their outer edge.

Rolling Gears

The designing engineer could save considerable metal on each ring by having them cast with a groove on the periphery instead of being straight-sided. Another and more material economy could be instituted by rolling-in the teeth of the gears instead of having them cut by machine. In this case it would be necessary to change the alloy, as phosphor-bronze is too brittle to roll. Manganese bronze would be suitable for the purpose, and aluminum-bronze also could be used, although from the bearing point of view there is little choice between aluminum or manganese-bronze.

Castings of the copper-tin alloys and manganese-bronze are used in the construction of diesel engines, and sometimes great difficulty is experienced in getting the desired physical qualities. The part of his work that causes the most anxiety to the brass founder, as it is responsible for the most failures, is melting the metals.

When castings of the copper-tin alloys are broken cold and the appearance of the fracture suggests the idea that a quantity of red and black pepper has been mixed in the metal, the fault should not be attributed to particular mixture employed, but to the mixer and melter.

To cast high grade copper alloys successfully requires as much skill as is demanded in any branch of the foundry industry, and all failures are due to inefficiency. When test bars fail, someone has blundered and the fractures of the bars furnish all the evidence required. In the conservation of metals, ignorance and inefficiency have no place, because with such factors to contend with, conservation is impossible. This applies also to the production of pure copper castings. The lack of the knowledge necessary to make castings of high electrical conductivity results in a greatly increased consumption of copper; in the case of alloys, inefficiency or the lack of the knowledge required to make the alloys in a manner that will obtain them free of all non-metallic impurities results also in a greatly increased consumption of metal, because alloys unskillfully made will be so much lower in ultimate strength and elongation than they should be, that castings must be made of larger section to obtain the required strength. A casting made to specifications and containing 10 per cent tin, with a little zinc and lead can be made to develop from 50,000 to 60,000 pounds tensile strength and from 40 to 50 per cent elongation. But such results could never be expected from the present state of the art; more probably the test bars would show a little over 30,000 pounds tensile, with from 6 to 10 per cent elongation. It is a fact, well-known in a general way, that specifications requiring a tensile strength of 35,000 pounds per square inch, with 15 per cent elongation are none too easy to meet in the average brass foundry. Much higher specifications than these should be complied with easily, and if they could be, as a matter of regular business, the patterns could be shaved accordingly, resulting in a saving of materials. The founder, of course, would sell less brass, but if a more equitable selling arrangement were adopted, he would realize a better profit than at present, because he would be better paid for the work accomplished, lose fewer castings and have less money tied up in metals.

Making Manganese Bronze

Great improvements also can be made in methods of producing manganese bronze. Foundrymen generally pretend to know how to make this alloy, and each has his own particular practice. The result is that manganese-bronze is supposed to be a difficult alloy to make, when in reality it is one of the most simple alloys to compound, when made by the use of a low melting point hardener containing iron in an easily soluble form, instead of being made by the use of the antiquated *steel alloy* with its erratic results. The standardizing of methods for making manganese bronze would bring important results from a conservation standpoint, since it would permit the alloy to be made of any quality desired, within a range of 60,000 pounds per square inch tensile, and 50 per cent elongation, to 90,000 pounds tensile and not less than 25 per cent elongation. In concluding the subject of copper alloys, it should be stated again that a standard method of making manganese-bronze is to be desired as there would result fewer failures entailing losses to the foundryman, and more dependable results would be attained by the engineer.

From a conservation point of view, there is not much to be said for lead as it is the cheapest metal used in the practice of making brass castings, and the tendency is to add as much to the alloys as the purchaser will stand for. It is a valuable constituent of alloys used for bearing purposes and in this case fills a legitimate function. Lead also is used to made alloys more machinable and could not be dispensed with for this purpose. The tendency, therefore, is toward an increased consumption of this metal.

Tin Economy

As tin is the most expensive metal employed in brass foundry practice, it is seldom used extravagantly, although it frequently happens that it is used inadvisedly. The foundryman usually makes it a point to economize on tin, in order to keep the cost of the mixtures to the point where he can do business and exist. There are numerous ways in which tin can be used economically; the most important consideration is to know when, how, and where to use it; in other words, it is the ability to select the right alloy for any stated purpose that counts as one of the greatest assets to the successful conduct of a brass foundry, whether large or small. It is an extravagance to put an alloy containing 10 per cent tin into a casting where an alloy with a content of 2 per cent tin would serve the purpose better, and yet this is frequently done. Small castings that are to be finished rapidly on monitor lathes do not require much tin; otherwise, the machine operator will complain that they are too *hard*. The same complaint will be voiced if the metal is too tough, due to low lead content. In making red brass low in tin, the practice should be adopted of adding the tin in the form of scrap, and to this end a careful study of the scrap metal piles will be well repaid. The pieces of scrap that experience suggests are likely to be rich in tin should be picked out and as it is not possible to get an analysis of such mixed material unless it is all melted down into ingots, it is a good idea to make a mental appraisement of the tin content of the selected scrap.

An old foundryman can do this by intuition, but a beginner would be at a loss as how to proceed. In the latter case, remember that one is never too old to learn, and commence a course of education as follows: Have a few alloys carefully made, and cast into bars 1 inch square by 6 inches long, in sand molds. Take the bars, when cold, and nick them ⅛-inch deep across one side in the center, and then break the bars. Next saw off one of the sections with a fractured surface, and place it in a corked, clear glass, wide-mouthed bottle and label the bottle in order to be able to identify the specimen. The reason for placing the samples in a bottle is that they would oxidize and change if exposed to the air and would soon become worthless for purposes of comparison. Make a number of these alloys with different percentages of tin, lead and zinc, corresponding to the alloys most commonly used; also bottle samples of the alloys that are being made regularly. The composition of any scrap can be estimated approximately, after a little practice, by casting it into a bar from the pattern used for the samples, and comparing the fracture with those of the standards, until one is found that resembles the scrap closely. Large pieces of scrap can be broken and compared with the samples without being melted.

Selection of Small Scrap

Small scrap is best compared by casting a test bar from a heat so selected from the pile as to be fairly representative. The scrap can then be used intelligently, to make red brass and other alloys, and the results can be checked by running a bar when casting the first heat, breaking it and comparing the fracture with the standard samples of that particular alloy. Turnings can be utilized in this manner just as well as scrap brass. It is important to know how to use scrap brass of all kinds in an intelligent manner, as by this knowledge it is possible to practice great economies in use of tin. Old metal remelted properly is as good as that made from virgin metals, and in many cases better, as it has been more thoroughly mixed by being melted several times. When remelted metal is consistently found to be inferior to new metal of the same composition, this is an indication that those responsible for the melting are not efficient, and in this connection it may be remarked that it is shortsighted policy to place the blame entirely on the man who attends the fires; get after the *man higher up*.

In a well-managed brass foundry very little return metal is allowed to accumulate in the bins of the metal room; when received, it will be immediately turned over, by being converted into castings of the same composition or into other alloys. The handling of metals to the best advantage is of vital importance to the brass founder as the competition is keen and the industry an old one; we are told that Tubal Cain, far back in Biblical times was the first brass founder and whether this is true or not, sufficient time has elapsed since brass founding became a business for it to be generally and quite thoroughly understood as far as the production of ordinary castings is concerned. There is no opportunity, therefore, for exorbitant profits and if economy is not practiced in the conduct of the business, sooner or later, depending upon the amount of the capital invested and available for the purchase of metals, the business will fail and become merely a memory.

Conservation of Zinc

The remarks concerning tin apply similarly to zinc, although this metal is not usually classed as an expensive one. It becomes expensive when wastefully used. The conservation of zinc is an important subject to the brass founder, as a considerable amount of metal loss can be traced to the volatilization of the zinc in melting the alloys. This usually figures out as so much brass loss; therefore, it is important to keep it as low as possible. This is another function of the melting end of the business, another index to the importance of this operation. Zinc is volatilized by *holding* metal in the furnaces after it has reached the pouring temperature, and while this practice occasionally may be unavoidable, it should not be allowed to become the standard under any consideration. The practice is usually due to the metal getting ahead of the molders, in other words, bad judgment is used in estimating the time necessary to make the molds. It is always better to let the molds wait for the metal, so that the latter can be removed from the fire when ready. Zinc loss is also promoted by the failure to use suitable fluxes to cover the metal. Charcoal as a cover is now universally employed, but is insufficient alone, and should be supplemented by one of the excellent fluxes now on the market. A flux that melts to form an air-tight cover over the molten metal in the furnace is a valuable adjunct to the melter and one which, when dispensed with, results in loss in many ways. It is advisable to always use something in addition to charcoal, but the latter should not be discontinued.

When small amounts of zinc are to be added to alloys, it is always economical to add it in the form of yellow brass of known composition, such as sheet brass clippings, etc.; this is due to the fact that the sudden volatilization of zinc, which occurs when it is added to hot molten copper or brass in the metallic form, is thereby avoided.

When making high-zinc alloys, such as manganese-bronze, it is not possible to avoid all volatilization of the zinc, but it can be controlled and kept at a minimum by skillful management, such as cooling down at intervals, or just before pouring, by the addition of reserve pieces of metal of the same composition.

Molding Sand Gets Right of Way to Oct. 15

Instructions have been issued by the commission on a car service of the council of national defense to the railroads of the country to include molding and furnace bottom sand in the list of commodities which are to be given preferred car movements. This action was vitally necessary to afford a supply of sand for the next 12 months, but the preferred movement of this material is to be confined only to the ensuing six months. Ample supply of this sand, it was pointed out, to the commission, is necessary to make possible the production of steel and iron products which will be required in large quantities in connection with the national defense. The foundries of the country have been operating on a hand-to-mouth basis because of a lack of rolling stock to move the sand. This has resulted in some foundries being closed down as well as a shortage of castings of all kinds.

The foregoing facts were laid before the commission by a committee representing the Ohio Sand Traffic Association. The committee was composed of President F. E. Gordon, Conneaut, O.; E. M. Ayers, Zanesville, O., and E. E. Klooz, Youngstown, O. The committee called upon the commission in Washington and was so successful in conveying to the commission the importance of the question under discussion that the latter body arranged at once to issue an order giving preferred car movements to molding and furnace bottom sand.

Members of the Ohio Sand Traffic Association include the following companies, all of which, except the Garden City Co., Chicago, have plants in Ohio: Gordon Sand Co., Conneaut; Portage Silica Co., Youngstown; Interstate Sand Co., Zanesville; Superior Sand Co., Cleveland; Standard Sand & Machine Co., Cleveland; Eberhard Co., Massillon; Oliver Silica Sand Co., Massillon; Newman Silica Sand Co., Massillon; Massillon Sand & Stone Co., Massillon; Beach City Silica Sand Co., Beach City; Keener Sand & Clay Co., Columbus; New Lexington Sand Co., New Lexington; Jones Sand Co., Columbus; Burton Townsend Co., Zanesville; Ayers Mineral Co., Zanesville; Garden City Sand Co., Chicago; Franklin Industrial Co., Massillon; Geauga Lake Silica Sand Co., Cleveland; National Sand & Stone Co., Niles; Summit Silica Co., Barberton, and the Millwood White Sand Co., Howard.

Keeping Down Operating Expense In A Small Gray Iron Foundry

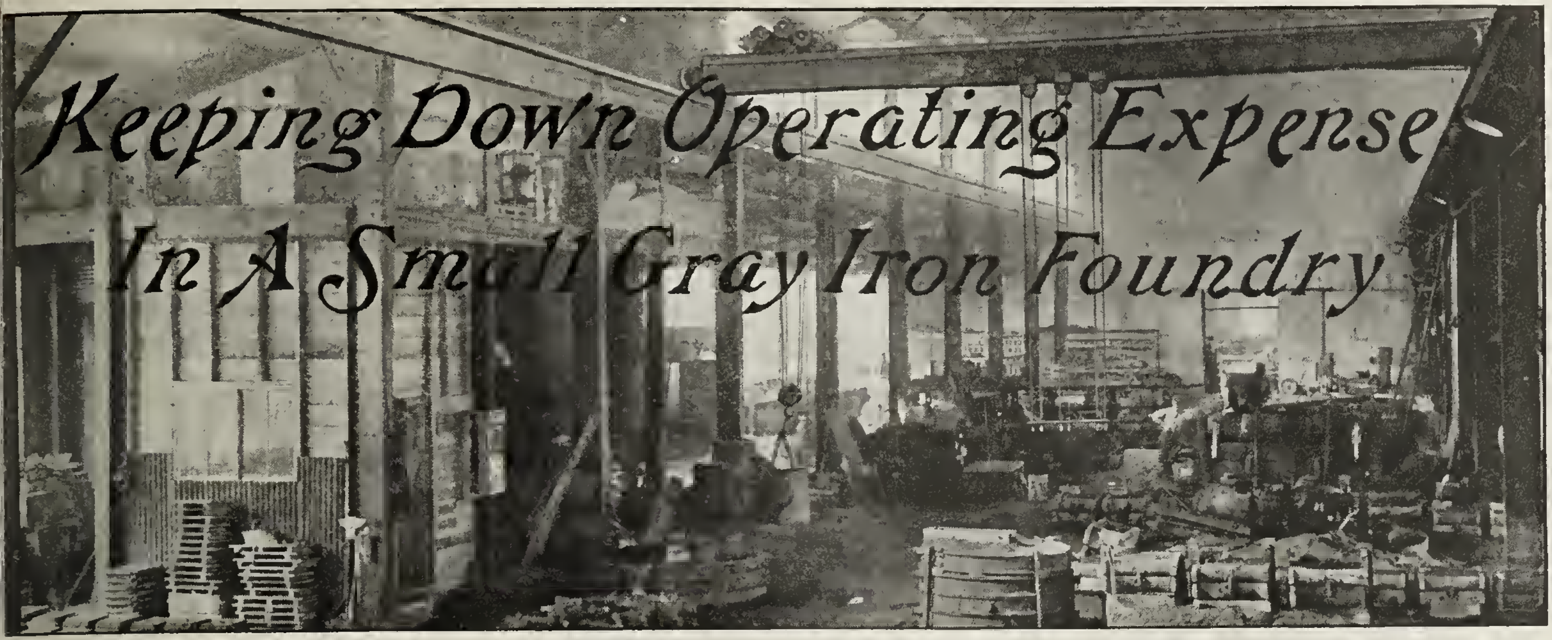


Fig. 1—Molding Floor in the Foundry of the Power Mfg. Co. The Crane is Operated from the Floor by Means of Ropes

How It is Done in An Ohio Shop

EXPERIENCED foundrymen know that the size of a foundry is not a reliable measure of the standard of ts equipment or the efficiency of its perating methods. Ordinarily, a large asting plant of modern design and with the latest type of equipment attracts considerable attention because of the spectacular nature of its intricate system of conveying machinery, cranes, molding machines, sand-blast and cleaning room equipment, etc. The very existence of expensive labor-saving apparatus suggests efficiency, although the implication is not always justified.

In the smaller plant, the evidences of careful planning and smooth operation are not so conspicuous. The margin between profit and loss is so narrow that the line between necessity and luxury must be finely drawn in purchasing equipment. Moreover, operating expenses must be kept within a well defined limit, and to accomplish this successfully, the foundryman must have reliable data to warn him when the costs threaten to leap out of bounds.

Simple Cost System

Methods that make for economy, together with a simple system of cost accounting, lend interest to the foundry of the Power Mfg. Co., Marion, O., manufacturer of fuel-oil engines. The business is the development of the early experiments of J. M. Primm, who in 1902 made his first successful engine in a modest factory in Van Buren, Ind. In 1907, when it became necessary to seek larger quarters, a plant consisting of two medium sized factory buildings was secured at Lima, O. In 1915, this plant was partially destroyed by fire.

The new plant, which is at Marion, O., consists of one large factory building and two auxiliary structures. The main building is 500 x 80 feet, and contains the machine shop and foundry. The machine shop occupies the south end and the foundry, 80 x 200 feet, is in the north end of this building. A bay, 40 feet high, traverses the entire length of the main building and is flanked on either side by a 20-foot bay. The side walls are of 8-inch brick construction, on which are mounted continuous sections of steel sash. The roof is of composition material laid on 1⅛-inch

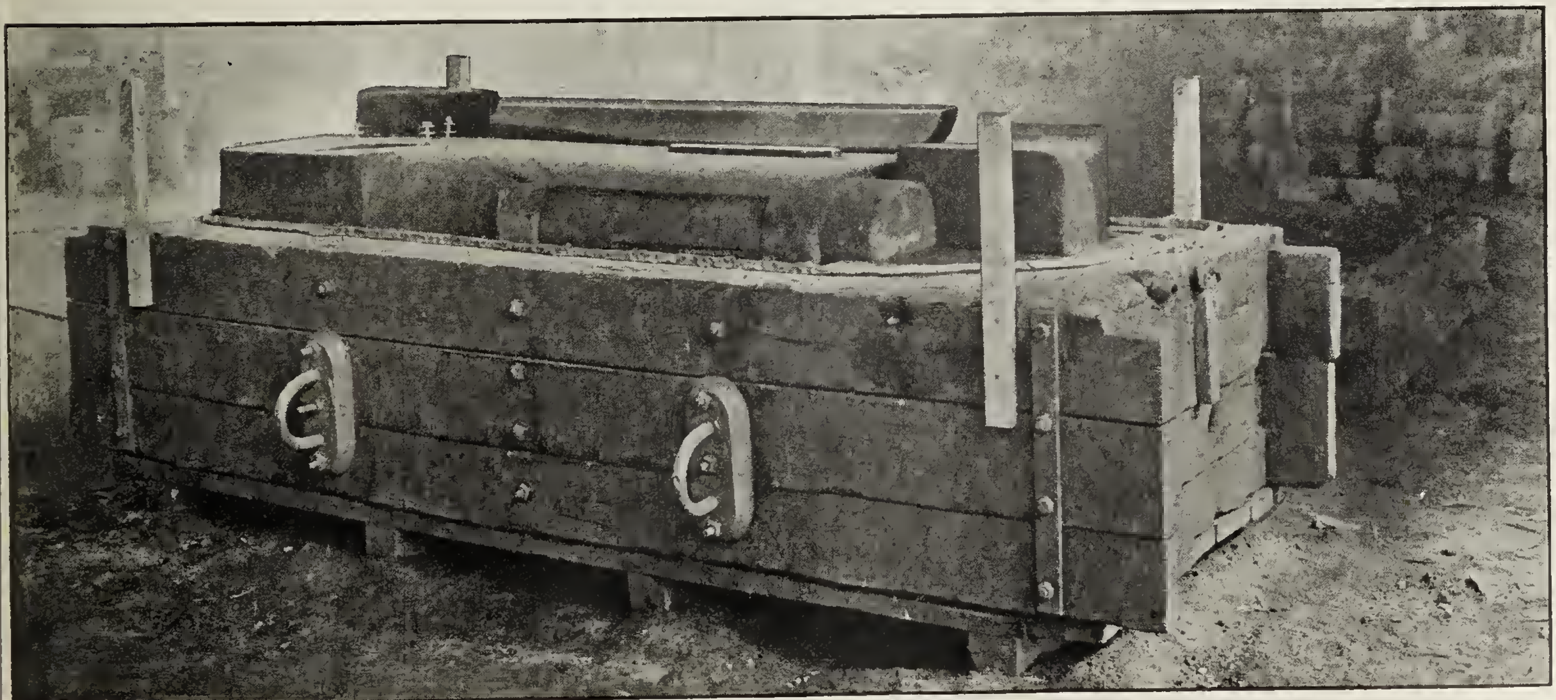


FIG. 2—DRAG OF MOLD FOR BED-PLATE OF 100-HORSEPOWER FUEL OIL ENGINE

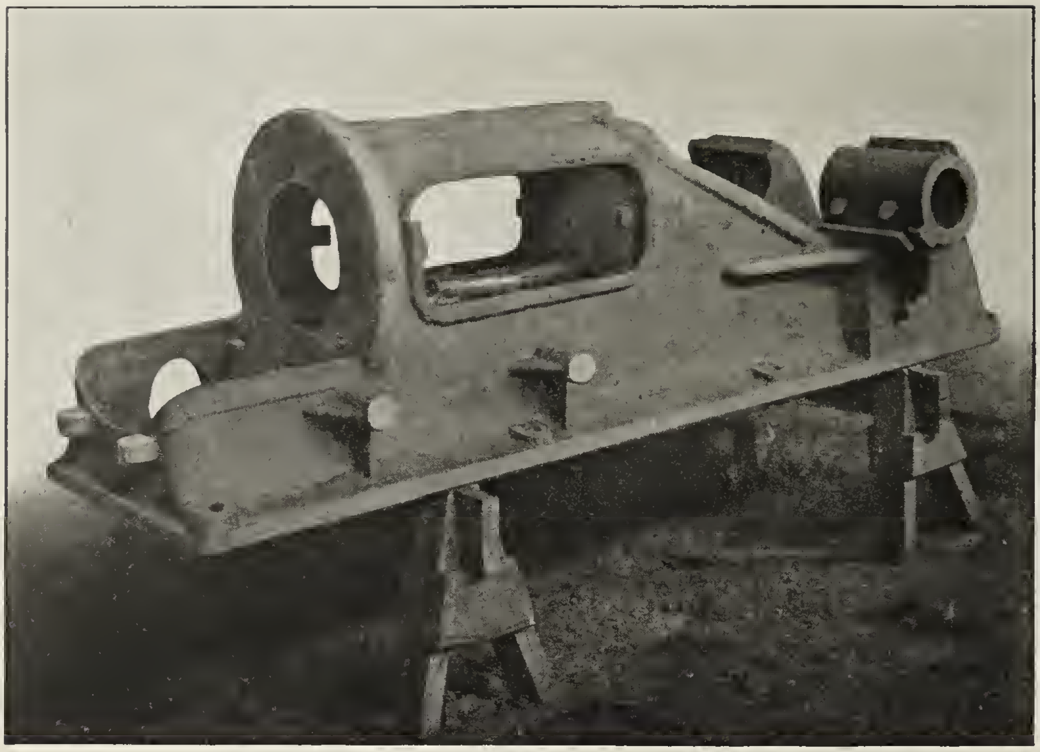


FIG. 3—BED-PLATE CASTING READY FOR THE CHIPPING HAMMERS

tongued and grooved sheeting. The floor of the machine shop is concrete.

The sole product of the Power Mfg. Co. consists of fuel oil engines which are used for hoists, mines, cotton mills, and in all kinds of work where the cost of steam outfits is prohibitive. At the present time, the foundry is engaged in the production of castings for engines, but in the future, it is thought that some jobbing work for outside concerns will be done. The castings made in the foundry consist principally of bed-plates, pistons, cylinders, flywheels, bearing caps and other smaller castings used in the plant.

Fig. 2, which shows the mold of a bed-plate for a 100-horsepower fuel oil engine, is typical of the work done in this shop. It will be noted that the pattern is embedded in the sand on its side and that the mold is parted in the center of the lug to which the cylinder is bolted. Although at present a split pattern is used, a solid pattern has been devised for this purpose. Although more cores will be required with the new patterns, it is believed that less trouble will be experienced in casting. As indicated in Fig. 2, the important part of the mold consists of the intricate cores. On account of the number of large cores required, the preparation of the mold for the bed-plate of a fuel oil engine requires two days. For this reason it is convenient to pour on every second day, thus allowing two days for the accumulation of a sufficient number of molds to warrant making a large heat. The finished bed-plate is shown in Fig. 3. In this illustration the casting is on horses ready for cleaning.

Handling Fuel and Iron

The cupolas, sand bins, core ovens, core room and pattern shop are situated at the east side of the foundry. The melting equipment consists of two cupolas, one 33 inches and the other 42 inches, inside diameter. At the present time, the pig iron, coke, etc., is brought from the storage yard on hand cars, run onto an elevator, lifted to the charging platform and there weighed and charged. A new system for handling the raw material, which will soon go into effect, involves the employment of an industrial railroad running alongside the storage bins for iron, coke, etc. The materials will be conveyed by cars on the tracks to a point near the elevators and there the charges will be made upon steel platforms suspended from automatic scales. When the proper amount of material has been placed on a platform, it will be dropped onto an elevated truck and run onto the elevator. The truck can be removed, and the platform lifted to the charging floor, where another elevated truck will be pushed under the platform. The charge on the platform then can be moved to a convenient place to await the time when it is to be used, or can be immediately placed in the cupolas, as required. The elevator was built by the Cincinnati Elevator Co., Cincinnati, and is operated by a clutch attached to a lineshaft driven by a 30-horsepower Westinghouse motor running at 900 revolutions per minute. This motor also drives a blower for the cupolas made by the P. H. & F. M. Roots Co., Connersville, Ind.

On account of the comparatively limited demands on the crane, it is not economical to devote the time of one man to operating this equipment which serves the main bay and is controlled from the molding floor by six ropes operating controllers hung on the lower side of the crane bridge. This system of control enables any workman to accurately direct the movement of the crane bridge, the overhead trolley or the hook by means of the ropes. The crane, furnished by the Euclid Crane & Hoist Co., Euclid, O., is used for handling flasks, cores and castings

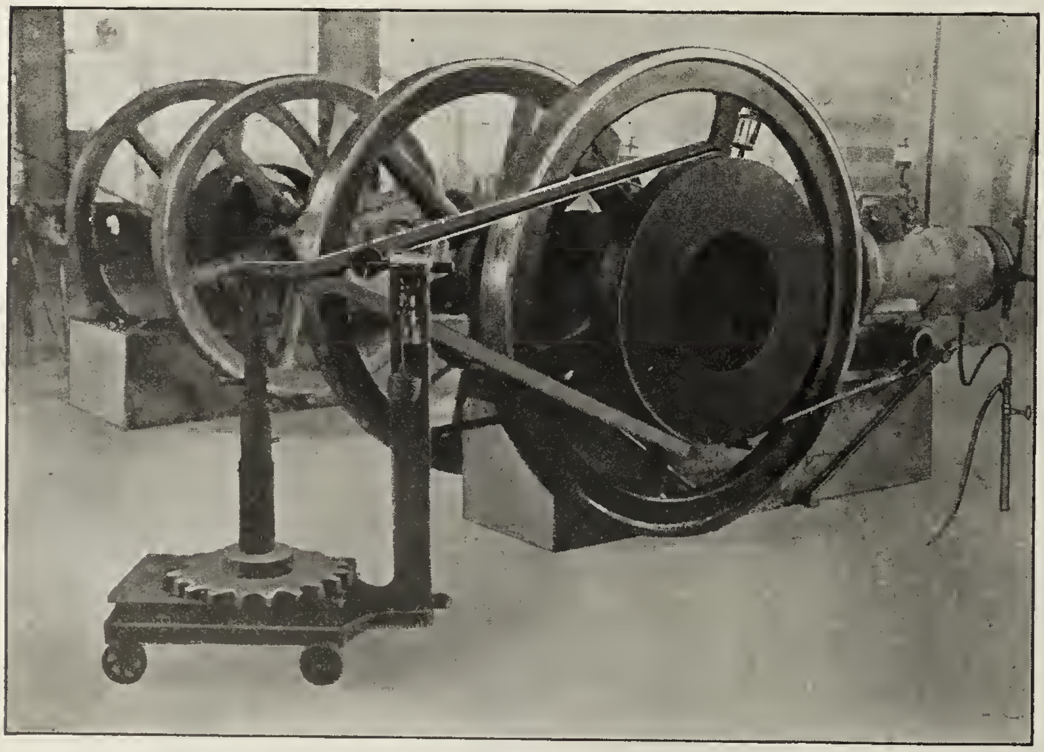


FIG. 4—FINISHED ENGINES ON THE TESTING RACKS—THE FLYWHEELS, BED-PLATES, CYLINDERS, CYLINDER HEADS, PISTONS, BEARING CAPS AND SEVERAL SMALLER PARTS ARE THE PRODUCT OF THE FOUNDRY

and in distributing metal to the molds. When cores are being lowered in molds, slings of 3-inch fiber belting are used. It is believed that fiber is better than leather for this purpose, as it is more pliable. The small machine bolts used to join the ends of the sling can be easily removed to release the core after it has been lowered onto the mold.

The methods employed in molding the various castings in this foundry are not unusual. One feature of the molding practice, however, will prove of interest. It is essential that the iron in all castings be of the best possible quality. To protect the company against loss from poor castings, an ingenious skim-gate is used. This gate, which was developed by the foundry foreman, consists of a round disc perforated with holes about 5/16-inch in diameter. The edges of the disc are tapered to fit the tapered holes of the gate in the flask. Fig. 5 illustrates how the skim-gates are made. The piece, *A*, is a master gage from which the core boxes, *B*, are made. Piece *A* is embedded in packed sand with the cup side down. Sand is packed around the outside and slicked off flush with the top. Then the staple, *C*, one leg of which is longer than the other, is inserted in the holes of the master gage. The short leg of the staple is just long enough to allow the long leg to enter the sand to a point flush with the outer rim on the other side of the master gage. After the holes have been punched in the sand, the mold is finished and poured, the resulting casting being a core box in which the skim-gate may be made. In making the gates, which are similar to that shown at *D*, core sand is packed in the core box, *B*, the extra sand is slicked off and the core box is then inverted on a flat board. After slightly tapping the core box, it may be lifted from the sand, and after the sand has been properly baked the skim-gate is finished. The rough edges or imperfect holes may be smoothed-up by merely rubbing the pieces of two gates together. The pouring basin is built-up around a post, *E*, which is tapered to fit the gate. In pouring, the perforated disc holds the metal back, allowing the dirt to rise to the top and permitting the clean metal to drop through the holes into the mold.

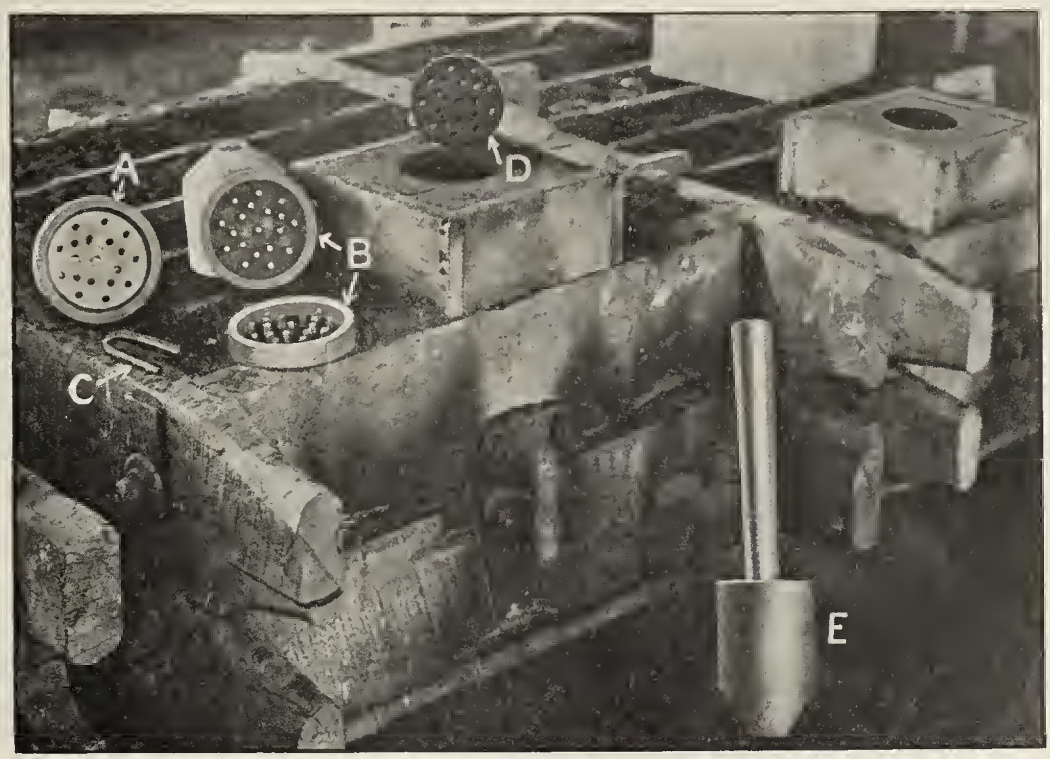


FIG. 5—HOW AN EFFECTIVE TYPE OF SKIM-GATE IS MADE—*A* AND *C* ARE USED TO MAKE THE CORE BOXES, *BB*

A Simple Gagger Board

Gaggers play an important part in a gray iron foundry. It is often desirable to make a simple gagger board at the lowest possible cost. The gagger board illustrated in Fig. 6 represents the minimum of labor and expense, it being made by means of cores instead of a mold of the ordinary kind. The cores are made from the half-pattern board shown at the right. This board is simply placed upon a bottom-board and packed with core sand. Two sand molds made in this manner are baked and then pasted together to form a single mold. These cores are placed in an upright position similar to that of the pattern board shown at the right in Fig. 6, and the metal is poured while the cores are in this position. After the metal has set, the cores are torn apart; one of the castings is shown at the left, Fig. 6. Ordinary silica sand which vents freely, is used for the cores in which this gagger board is made.

The foundry is equipped with various details of auxiliary equipment which greatly reduce operating expenses. The molds are dried by gas torches supplied from gas lines suspended from each column in the building. Air lines parallel the gas lines, the pressure being maintained at 70 pounds per square inch. The air is used in connection with the gas torches and for driving the pneumatic chipping hammers. Sand for the molds is sifted by means of a Combs gyratory riddle manufactured by the Great Western Mfg. Co., Leavenworth, Kans. In addition to the ordinary gas

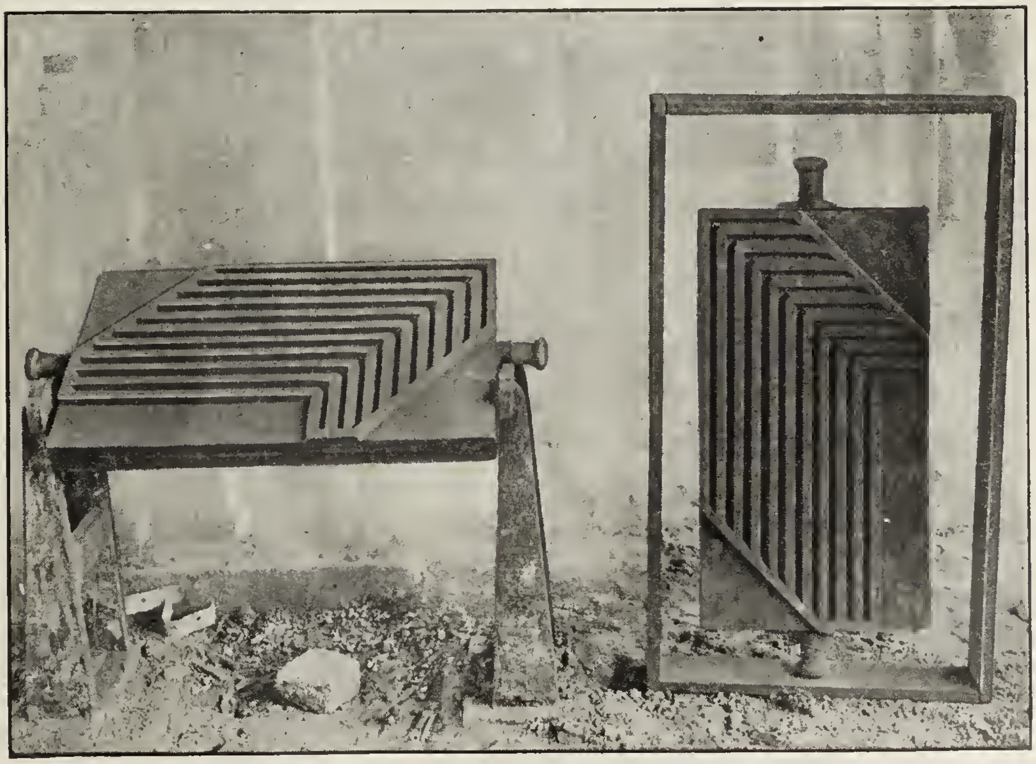
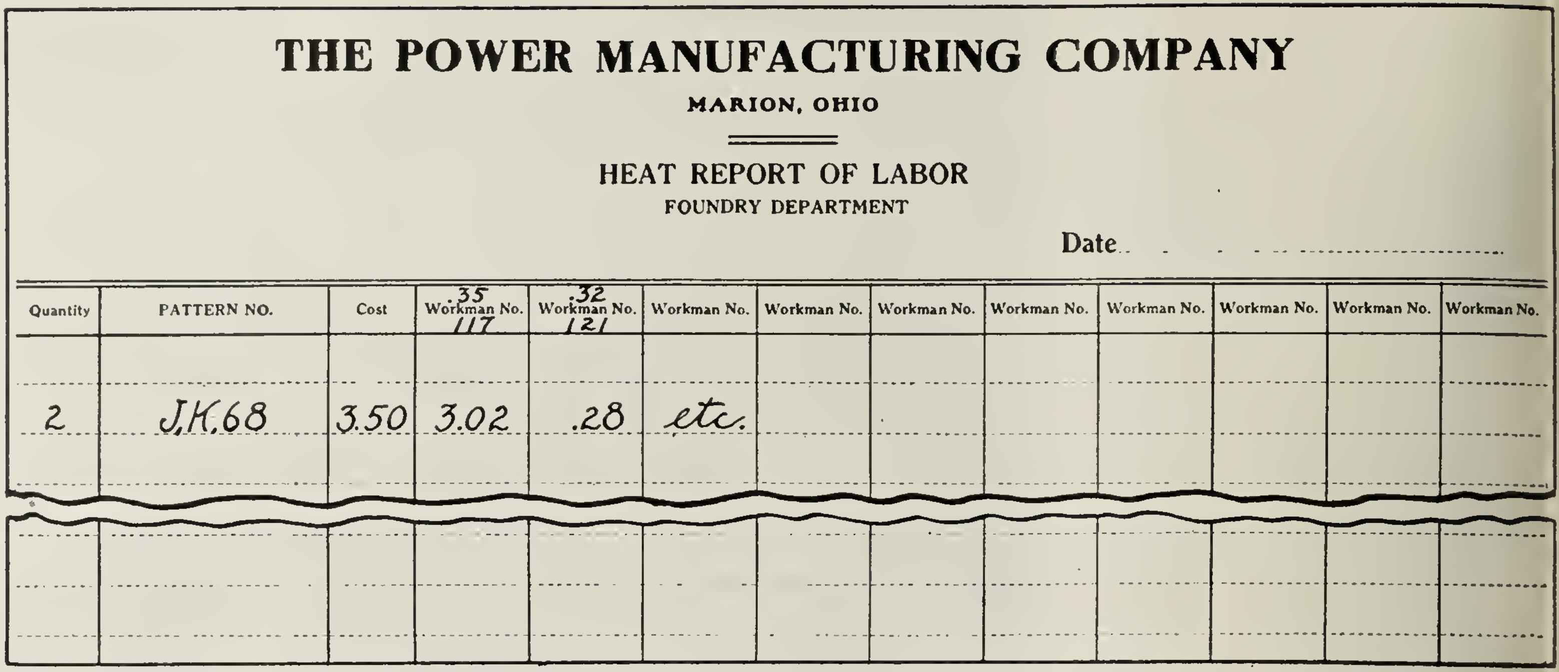


FIG. 6—A GAGGER BOARD IS A USEFUL ADJUNCT TO THE FOUNDRY—INSTEAD OF USING AN EXPENSIVE PATTERN AND AN INTRICATE MOLD TO MAKE THE GAGGER BOARD, CORES ARE MADE FROM A HALF BOARD, PASTED TOGETHER, AND USED AS A MOLD



THE POWER MANUFACTURING COMPANY
MARION, OHIO

HEAT REPORT OF LABOR
FOUNDRY DEPARTMENT

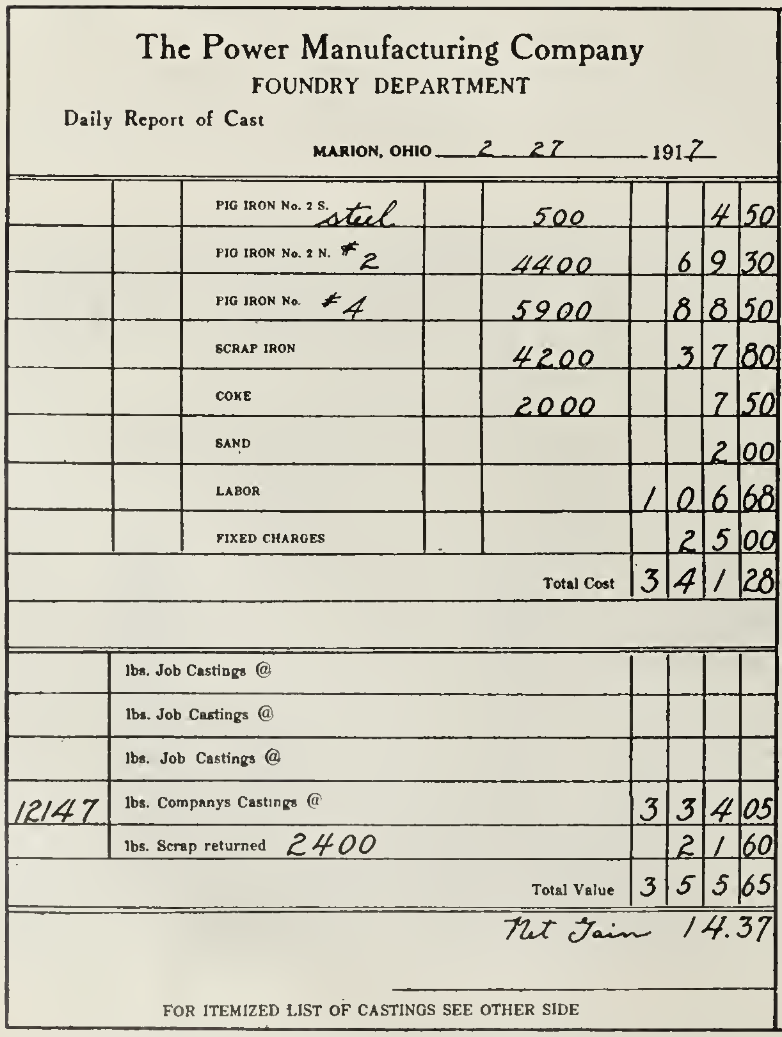
Date..................................

Quantity	PATTERN NO.	Cost	Workman No. 117 (.35)	Workman No. 121 (.32)	Workman No.	Workman No.	Workman No.	Workman No.	Workman No.	Workman No.	Workman No.	Workman No.
2	J.K.68	3.50	3.02	.28	etc.							

FIG. 7—THE LABOR CHARGES ON THE VARIOUS JOBS ARE COLLECTED FROM TIME SLIPS AND ARE ENTERED ON THIS FORM

flame for drying molds, small torches, furnished by the Mahr Mfg. Co., Minneapolis, are used. Sand for all purposes is mixed by a Blystone mixer.

One of the problems which confronted the engineers who laid out the foundry was the design of a suitable core oven. An oven of the car type, 14 feet wide, 20 feet long and 7 feet 8 inches high, was built and lined with refractory brick. In one corner of the oven, a grate, 3 feet square, was provided. It was designed for coke and it was planned that this fuel would be charged in the evening just before quitting time in a sufficient quantity to last all night so that the cores would be properly baked when the men resumed work in the morning. This plan proved satisfactory as long as the price of coke remained at from $2 to $5 per ton, which prices prevailed when this equipment was first installed. However, when the price of coke approached $10, the company decided that this fuel could no longer be used economically in the core oven. Therefore, the grate was slightly altered to accommodate bituminous coal instead of coke, and this has since been used. About 225 pounds of coal are charged each evening and this is sufficient to last all night. The cores are properly baked when



The Power Manufacturing Company
FOUNDRY DEPARTMENT
Daily Report of Cast
MARION, OHIO 2 27 1917

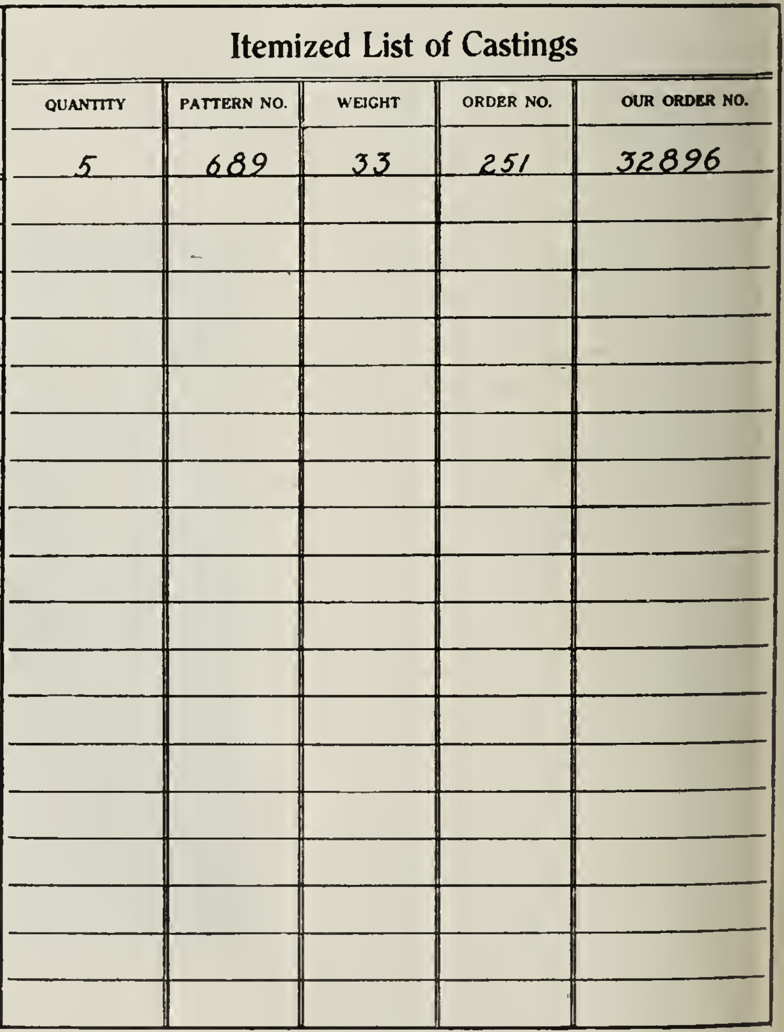
		PIG IRON No. 2 S. steel	500	4 50
		PIG IRON No. 2 N. #2	4400	69 30
		PIG IRON No. #4	5900	88 50
		SCRAP IRON	4200	37 80
		COKE	2000	7 50
		SAND		2 00
		LABOR		106 68
		FIXED CHARGES		25 00
		Total Cost		341 28

	lbs. Job Castings @	
	lbs. Job Castings @	
	lbs. Job Castings @	
12147	lbs. Companys Castings @	334 05
	lbs. Scrap returned 2400	21 60
	Total Value	355 65

Net Gain 14.37

FOR ITEMIZED LIST OF CASTINGS SEE OTHER SIDE

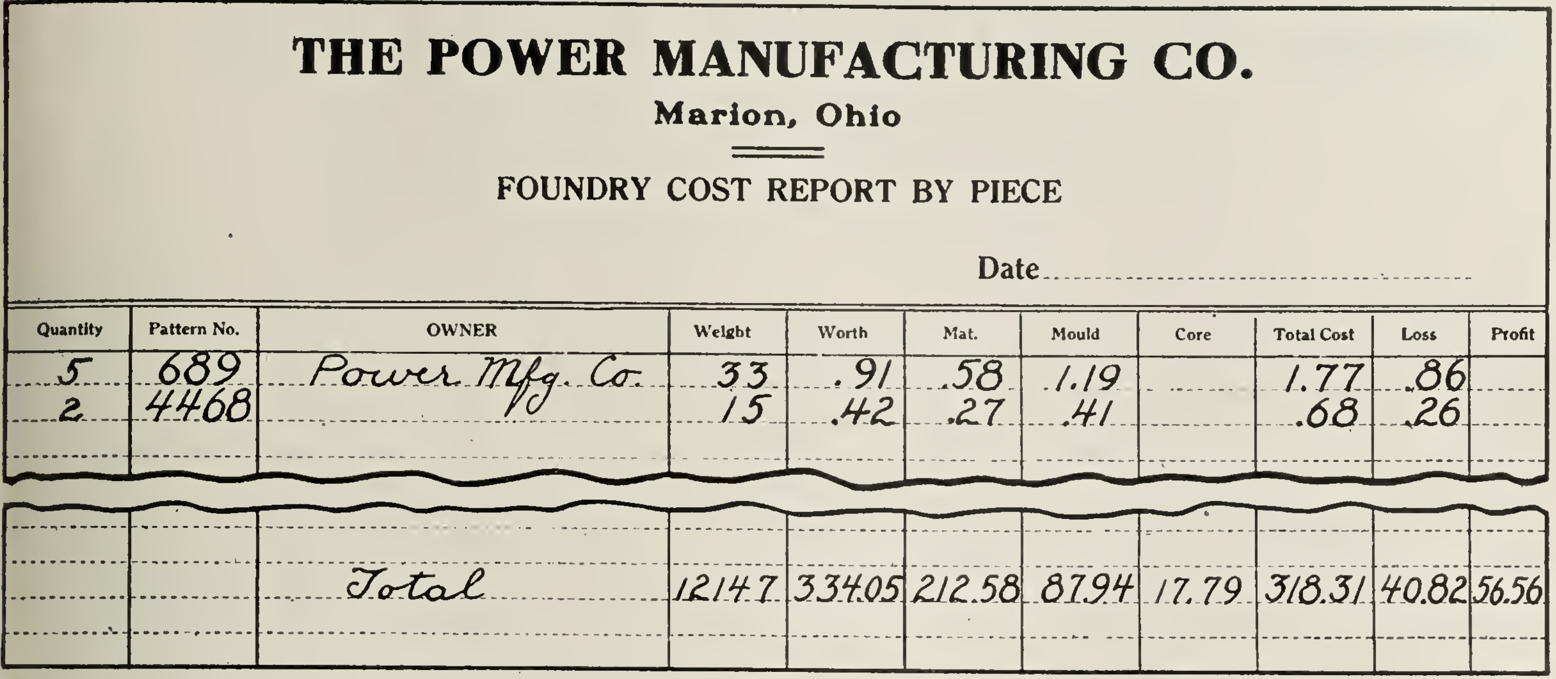
FIG. 8—FACSIMILE OF FACE OF DAILY REPORT CARD SHOWING SUMMARY OF EXPENSES AND VALUE OF THE PRODUCT



Itemized List of Castings

QUANTITY	PATTERN NO.	WEIGHT	ORDER NO.	OUR ORDER NO.
5	689	33	251	32896

FIG. 9—FACSIMILE OF REVERSE SIDE OF DAILY REPORT CARD—THE CASTINGS MADE, THEIR QUANTITY AND WEIGHTS ARE LISTED



THE POWER MANUFACTURING CO.
Marion, Ohio

FOUNDRY COST REPORT BY PIECE

Date

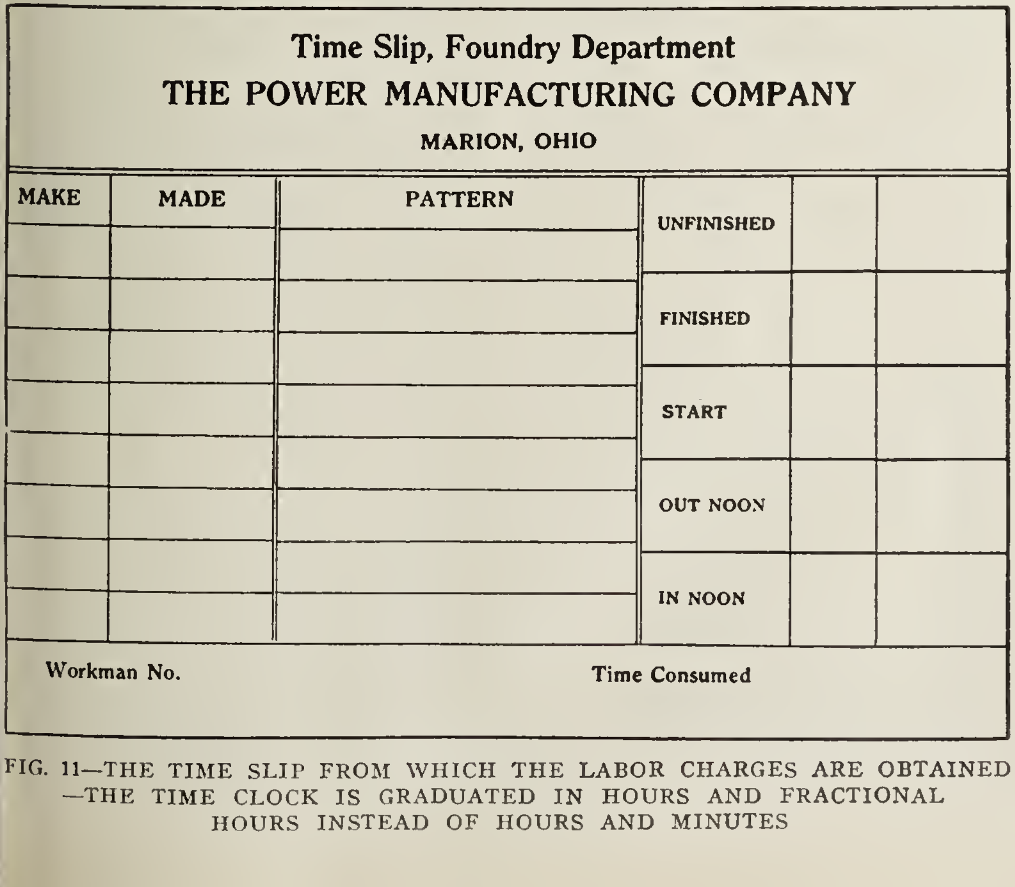
Quantity	Pattern No.	OWNER	Weight	Worth	Mat.	Mould	Core	Total Cost	Loss	Profit
5	689	Power Mfg. Co.	33	.91	.58	1.19		1.77	.86	
2	4468	〃	15	.42	.27	.41		.68	.26	
		Total	12147	334.05	212.58	87.94	17.79	318.31	40.82	56.56

FIG. 10—A COST REPORT WHICH ENABLES THE FOUNDRYMAN TO CHECK-UP THE COST OF EACH GROUP OF CASTINGS

taken out in the morning and so efficient is this core oven that small cores placed on the floor of the oven are suitably baked when discharged. This represents a big improvement over the operation of the coke-fired oven, when it was necessary to change the position of various cores in order that they might receive the proper degree of heat. The cost for fuel for this oven averages less than 35 cents per day.

Cost Accounting System

It is usually true, in the case of a small foundry, that the balance between profit and loss is easily disturbed by lack of economical methods in certain operations in the foundry. Therefore, it is essential that an accurate and simple cost accounting system be employed in order that the foundryman may know at all times how closely he is adhering to the estimated cost of the product. Figs. 8 and 9 show the daily report of castings which is filled out at the foundry of the Power Mfg. Co. On one side of the sheet are shown the amount of pig iron, gas, coke and sand used for the heat. As shown in Fig. 8, the amount filled-in in the last column indicates the actual cost of the material and labor and the fixed charges. The total, which in this case amounts to $341.28, should agree with the determined value of the castings made. At the bottom of the face of this sheet, it is shown that 12,147 pounds of castings, valued at $334.05, were made for the company. It is also shown that 2,400 pounds of scrap were returned, and this represents a credit of $21.60, which is added to the value of the castings made. This gives a total value of $355.65, which is $14.37 in excess of the total cost of these castings. The $14.37 represents the net gain for the day. On the opposite side of this sheet, which is illustrated in Fig. 9, are listed the quantity, pattern number, weight and order number of the various castings made from this particular cast. The total weight shown on the reverse side of the daily report of castings made should agree with the total in the lower part of the front side of the sheet.

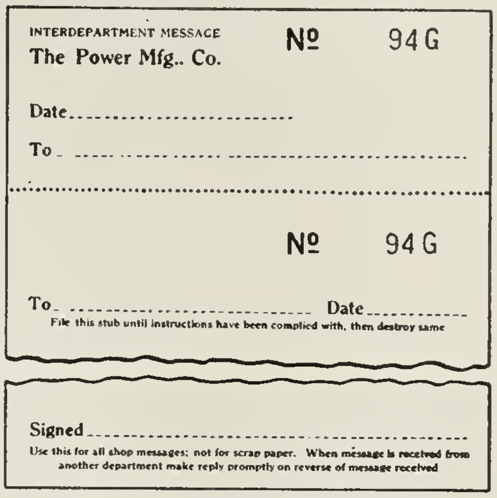


Time Slip, Foundry Department
THE POWER MANUFACTURING COMPANY
MARION, OHIO

MAKE	MADE	PATTERN			
			UNFINISHED		
			FINISHED		
			START		
			OUT NOON		
			IN NOON		

Workman No. Time Consumed

FIG. 11—THE TIME SLIP FROM WHICH THE LABOR CHARGES ARE OBTAINED —THE TIME CLOCK IS GRADUATED IN HOURS AND FRACTIONAL HOURS INSTEAD OF HOURS AND MINUTES



INTERDEPARTMENT MESSAGE
The Power Mfg.. Co. № 94G

Date

To

№ 94G

To Date

File this stub until instructions have been complied with, then destroy same

Signed

Use this for all shop messages; not for scrap paper. When message is received from another department make reply promptly on reverse of message received

FIG. 12—A SIMPLE FORM FOR INTER-DEPARTMENTAL MESSAGES

Data from Time Slips

In filling-out the items shown at the top of Fig. 8, the cost of material such as steel, No. 2 pig iron, No. 4 pig iron, scrap iron, coke, etc., is taken from records giving the cost of the material. The fixed charges have been previously determined, $25 representing the average which is charged to each day's cast. The amount applicable to labor is determined direct from the time slips punched with a time clock by the workmen in the foundry. These time cards are similar to the one shown in Fig. 11.

(*Concluded on page 222*)

Castings From Acid and Basic Electric Steel

Pertinent Suggestions From a Practical Operator Bearing Upon This New Foundry Process for the Production of Small Castings

By A Walter Lorenz

ONLY a few years ago the application of the electric furnace to the manufacture of steel was chiefly confined to the making of high-grade metal where cost was of secondary importance to the quality of the product. Within the last few years, however, a wide field has been found for electric furnaces in the manufacture of small steel castings. This has been due partly to the demand for a superior product, but mainly to the constantly decreasing cost of electric power, which now enables this process to enter into active competition with the older methods. Electric steel cannot yet be made in large quantities as cheaply as either acid or basic open-hearth, except in certain districts, and for this reason we do not find many plants devoted to the manufacture of large electric steel castings.

Low Cost of Electric Steel

Electric steel really can be made at the present time at a much lower cost than is generally imagined. The prevailing impression that the cost of power is prohibitive deters many from fully investigating the economical features of electric practice. It will be found that the cost of power will be compensated for to a large extent by the lower cost of raw material used (plate scrap, etc.), as compared with the cost of pig iron. At the present time, this is quite a considerable item. Moreover, the cost of ferro-manganese, ferro-silicon, and other special additions per ton of electric steel is only a small fraction of the cost of similar additions per ton of steel made in other furnaces. This saving is effected by the use of low-grade alloys and by the fact that the amount of alloy required for a ton of ordinary electric steel is very small. In the basic electric process, for instance, the bath when melted always contains from 0.20 to 0.30 per cent manganese, and it is only necessary to raise this 0.50 per cent to secure a product as good as the average converter product of 0.60 to 0.70 per cent manganese. Even this small increase of 0.2 is accomplished with a minimum of manganese, since there is absolutely no loss. One electric steel plant figures that its manganese additions cost only $0.09½ per ton of steel.

When the electric furnace first entered this field, basic practice had already become standard in the manufacture of electric tool steel, and for this reason, perhaps, we find that a similar practice was adopted for the manufacture of steel for casting purposes.

Basic Furnace Bottom

The furnace bottom for basic practice is made up of magnesite. This is sometimes bonded with tar, but since this type of bottom has not proved very satisfactory, due probably to lack of experience in building, it is the usual practice to mix the magnesite with about 20 to 25 per cent basic slag. This mixture is burned-in thoroughly, a layer at a time, by means of the electric arc. Objection may be found to this type of bottom also, for even though iron oxide in the form of basic slag is an accepted bonding material for basic open-hearth bottoms. its use in the electric furnace for a similar purpose is questionable. Here there are strong reducing influences at work, which are not present in open-hearth practice, and under these influences the iron oxide is readily converted into metallic iron. A striking example of this action came to the attention of the writer recently while inspecting the fresh bottom of a new furnace. This bottom was made by burning-in a mixture of magnesite and basic slag by means of the resistance generated in a pile of coke and broken electrodes placed on top. When the furnace was opened, the bottom, for a depth of about 6 inches, was almost white in color and slaked rapidly in air, while particles of iron ranging in size from small globules to pieces the size of an egg were interspersed throughout the mass. By reduction to metallic iron, the iron oxide not only loses its bonding properties, but may even be injurious, since the metallic iron formed has a tendency to become pasty and melt under high temperature, loosening portions of the bottom, and thus cause trouble, as will be noted later. Difficulties of the foregoing nature, however, are rare, and, on the whole, a bottom of this type gives satisfactory service.

Theoretically, any kind of scrap should produce good metal on a basic bottom, but there are certain considerations which demand the use of clean, high-grade material in this no less than in the acid process. The scrap must not be dirty, or the impurities will rapidly attack the lining and bottom, under the influence of the high heat, which prevails in all electric furnaces. It would seem that the percentage of phosphorus and sulphur in the raw material should be of little consequence, since one important advantage claimed for the basic-lined electric furnace is the ability to remove them almost entirely. This is quite true, but these elements, especially phosphorus, can be removed almost as completely in a basic open-hearth furnace, and at much less cost, so that it seems poor policy to do any unnecessary refining in the electric furnace, and it will generally be more economical to use fairly good scrap in the first place.

Charging the Furnace

When charging, the scrap, consisting of heads, gates, plate punchings, rails, or other clean material of good quality, is placed in the furnace with the required amount of lime for slag-making purposes. When using scrap under 0.075 per cent phosphorus, there is generally sufficient oxide in the charge to carry the greater part of the phosphorus into the slag. When the charge is thoroughly melted, this phos-bearing slag is drawn off as completely as possible. Such a slag has practically the same composition as a normal basic open-hearth slag, although considerably lower in iron oxide. Some manganese is carried off with this slag, but its removal in the basic process is never as complete as in the acid, and, as stated previously, 0.2 to 0.3 per cent always will be left in the bath. If slagging has been carefully conducted, the bath will be practically free from phosphorus, but will still contain considerable sulphur.

Another slag is now formed by the addition of more lime, which is cut up with a little sand or fluorspar. A reducing action is now started by the addition of silicon or carbon. As silicon is comparatively expensive and it is difficult to regulate the silicon content of the bath when this material is used, it is more general to employ carbon. In this case, when the slag is sufficiently fluid, powdered coke is added, which interacts slowly to remove the oxides present and afterward to form calcium carbide. The manganese may be introduced at almost any time; the sooner the better, as it helps in the deoxidation of the bath and removal of the sulphur. The attainment of a good carbide slag has been held to be an indication that deoxidation is complete. It is certainly an indication that deoxidation of the slag itself is complete, since a carbide slag rarely contains over 0.5 per cent of the oxides of iron and manganese.

It cannot be said, however, that a carbide slag is evidence of a deoxidized bath, nor does it seem to be true, as has often been claimed, that a carbide slag plays any great part in the complete deoxidation of the bath itself, except to act as a protective coating against the air. The writer has seen metal, which after laying under a carbide slag for an hour, still seemed as wild as ever. This statement refers, of course, to baths low in carbon, which are always more difficult to deoxidize than high carbon melts. The addition of some alloy, such as ferro-silicon, which will thoroughly disseminate itself through the bath, rather than a substance which merely floats on top of it, seems necessary in order to remove the last traces of oxide, for the circulation in the bath itself is of little consequence in most electric furnaces.

Regulation of Manganese Content

The almost complete reduction of MnO from the slag attests to the ease and exactness with which the manganese content of the bath may be regulated. If the residual manganese in the bath after removal of the first slag has been determined by analysis, then it is only necessary to add the exact amount lacking, to bring it up to the desired percentage. No other method (except the crucible process) is capable of regulating manganese with such great accuracy.

Carbon always should be adjusted near the end of the heat, since pieces of electrodes, or coke from an imperfectly fused slag, may enter the bath and cause trouble after the carbon, from all indications, is about right. If this should occur, it may mean the loss of much time and energy, since the carbon cannot be removed after the reducing period has commenced except by bringing the furnace back to an oxidized condition by means of ore, after which it is again necessary to repeat all the subsequent operations of reduction before the heat can be tapped. For this reason it is advisable to bring the carbon well on the low side before commencing reduction, and then add the requisite amount of carbonizing material at the end of the heat to bring the carbon up to the desired percentage. In this way the carbon can be regulated with great accuracy by an experienced melter.

The Control of Silicon

The control of silicon presents some difficulties. While it has been said that no loss attends the introduction of silicon in the electric furnace, this statement does not always hold true. The silicon content of the melt may sometimes come out exactly as calculated if conditions are right in the furnace, but it may just as often be high or low. The obvious reason for adding silicon to steel is to complete the deoxidation, and in the performance of this function, some silicon must necessarily go to the slag. It has already been said that a carbide slag alone is insufficient to deoxidize a low carbon bath perfectly. Not until the addition of silicon does the bath become perfectly quiet. Hence, we can generally figure on losing a small amount of silicon in this way. On the other hand, if reducing conditions are extremely powerful within the furnace, and the slag is not sufficiently basic, then some silica from the slag may be reduced, and even more will be found in the bath than was desired.

The writer has found the silicon in various heats of electric steel treated in the same manner to vary about 0.20 per cent, being sometimes higher and sometimes lower than calculated. Of course, such a variation is by no means harmful in casting steel, and attention is merely called to the matter here to show the variations between theory and practice. Silicon generally is added from 10 to 30 minutes before a heat is tapped. It may seem that a somewhat longer treatment should produce better results, but this may lead to trouble on account of the fact that no matter how perfectly a bath has been deoxidized, and no matter how free from oxides is the slag which covers it, the bath, nevertheless, is lying on a bottom which contains a considerable proportion of iron oxide.

Magnesite generally contains 5 to 8 per cent, Fe_2O_3 and basic slag, frequently used for bonding purposes, 10 to 15 per cent, FeO. This bottom always has a tendency to react with a well deoxidized bath, especially if pieces of bottom have become loose during the course of a melt, and it sometimes happens that an excellent heat may be ruined by the coming-up of a portion of the bottom just before tapping-out. The interfering action of the bottom would, of course, cause loss of an appreciable amount of silicon if this was left in the furnace for too long a period. Regarding the addition of aluminum in the furnace for the final deoxidation, which is held to be one of the advantages inherent to basic electric practice, it may be said that no benefit seems to be derived from this procedure. Even if the bath has been perfectly deoxidized in the furnace, there is always a certain amount of deoxidation during pouring, and for this reason many electric steel casting manufacturers have gone back to the addition of aluminum in the ladle.

While some of the foregoing statements may not fit into the general conception as to the possibilities of the basic electric process, it must be expected that many difficulties will arise in the manufacture of steel castings which are not present in the making of steel for forging or rolling purposes. For this reason a compromise must sometimes be made between theoretical considerations and the possibilities of actual practice. Such difficulties as are encountered are of a minor nature, and the practice is gradually being improved and standardized, so that at the present time castings of excellent quality are being made.

The Acid Process

The chief advantage of the acid process lies in the fact that heats can be run out in less time than on a basic lining, resulting in greater output with decreased power consumption.

A careful selection of scrap is necessary in order to keep the impurities at a minimum. Removal of phosphorus and sulphur as in the basic process is not possible, but this is only a small disadvantage, since by the use of basic open-hearth scrap the phosphorus may readily be kept below 0.02 per cent and the sulphur below 0.03 per cent. Acid electric practice follows in general along the same lines as acid open-hearth, except for a final reduction period, during which all oxides are practically eliminated from the bath. Deoxidation must be accomplished by ferromanganese almost entirely, since coke has a tendency to react with the large percentage of silica, in an acid slag, introducing an undesirable amount of silicon into the bath. It is unnecessary, as a rule, to add ferro-silicon to the bath in the final stages, and, in fact, one of the problems of acid electric practice is to keep the silicon within due bounds. Its regulation is not nearly as simple as in the basic process, and it may sometimes run as high as 0.6 per cent. Whether silicon in this proportion is injurious to the steel is still a debatable question among metallurgists.

Since manganese is the chief reducing agent employed in the acid process, it follows that this element cannot be regulated as well as in the basic process, as it is difficult to tell just how much has been used for oxidation and how much remains in the bath. Practice enables a melter to regulate it within fair bounds by means of mechanical tests and standardization, but its adjustment can never be as satisfactory as in the basic process.

Deoxidation on Acid Bottom

It has been claimed on theoretical grounds that deoxidation in an acid bottom cannot be as perfect as on a basic bottom, but practical results would indicate that the final products are about equal in this respect. It is true that a final slag from an acid heat will be much higher in oxides than the calcium carbide slag of a basic furnace, but the oxygen is almost entirely combined as MnO, and the percentage of iron oxide is just as low as in a basic slag, being under 0.5 per cent, with the MnO running about 10 per cent. It is evident that the manganese performs its function well, and even though the percentage of MnO is high, the affinity of manganese for oxygen is such as to prevent reabsorption of oxygen from this source by the bath. In other words, the MnO is perfectly neutral and seems to have no effect whatever on the bath.

Carbon can be regulated at will by the melter with approximately the same precision as in basic practice. Acid electric steel is somewhat easier to pour than basic steel, since a basic carbide slag does not clean well from the molten metal. Aluminum is added in the ladle.

Acid and Basic Steel Similarities

To all intents and purposes, except for regularity of chemical composition, acid electric steel in the ladle, in the mold, and in use, seems to be identical with basic steel when proper care has been employed in its manufacture. Molding and foundry practice play a large part in the production of perfect castings, and after all, the quality of the metal itsef is only one factor to be considered when comparing the ultimate product. Each process has its merits and until the product of one shows a decided superiority over that of the other, the final decision will probably be made by the steel foundryman himself in favor of the process best adapted for economical operation in his particular field.

Electric furnace practice today is, of course, capable of great improvement. There is much faulty design to be corrected, and there are many problems in practice which still remain unsolved, due mainly to lack of experienced operators.

Keeping Down Operating Expenses in a Small Gray Iron Foundry

(*Continued from page* 219.)

Each workman fills out the first, second and third columns showing, respectively, the number of pieces he was to make, the number he did make, and the pattern number of the piece. The clock punches hours and decimal parts of hours instead of hours and minutes. Inasmuch as the columns are arranged for the convenience of the time clerk rather than the convenience of the workman, it is necessary only to subtract the amount shown in the first and second columns to secure the net amount of time consumed on a fixed job. The information on these time slips is then collected by the time clerk on the last form entitled "Heat Report of Labor", shown in Fig. 7. On this report are spaces in which the time consumed by various workmen may be entered and the overhead expense is entered in the first column under the heading "Cost". The total from each of these sheets represents the amount shown under "Labor" in the form shown in Fig. 8.

As a check to determine whether any castings are costing more than the estimate made, the form shown in Fig. 10 is used. Information for the first two columns of this form is taken from the back of the daily cast report, illustrated in Fig. 9. The amount shown under "Worth" is obtained by multiplying the weight in pounds by the estimated value of the castings. In the following column, the actual cost taken from time cards and from material sheets, is entered and then the total cost, as compared with the estimated value of the castings, indicates at a glance whether the job has been done at a loss or a profit. The difference between the total loss and total profit should approximate the net gain or net loss shown on the face of the form, Fig. 8. This comparison is a test of the accuracy of the system.

It is the experience of many men in manufacturing plants that much of the routine correspondence between offices usually is handled in a slip-shod manner. Fig. 12 shows a blank for interdepartmental messages which has proved of unusual value in the plant of the Power Mfg. Co. It is useful for correspondence which does not merit the dignity of a letter-head. The numbered stub is retained as a reminder until the reply, written on the back of the sheet, is received. The use of this form has encouraged the prompt handling of messages.

Losses in Melting Cast Iron

By W. J. Keep

Question:—We would like to know the percentage of melting loss in the operation of a small foundry. What are the average yard losses in handling pig iron? Also, kindly advise the yard losses in handling and breaking scrap iron.

Answer:—It is impossible to ascertain such losses in the ordinary foundry routine. Some years ago, to ascertain the actual loss, I swept the foundry floors, scaffolds, riddled the sand heaps and made one-ton heats of pig and scrap and also made one regular heat. The results are given in the following table:

One ton heats of each	Pounds loss per ton	Percentage of loss
No. 1 Cherry Valley pig iron, silicon, 2.72 per cent; sulphur, 0.01 per cent	59	4.75
Cleaned new stove plate	159	7.59
Cleaned stove plate sprues	130	6.50
Old stove plate scrap—purch.	227	11.35
New stove plate with sand on	230	11.50
New stove plate sprues with sand on	280	14.00
A 37-ton heat of regular melt of stove plate:		
Calculated from above experiments	116	5.80
Actual, all precautions taken.	88	4.41

The regular heat consisted of 37 tons and the shot and screenings recovered from the gangway amounted to 26 pounds per ton of iron melted. The coke recovered from the cupola totaled 57 pounds per ton; limestone flux used, 43 pounds per ton; slag tapped out, 207 pounds per ton, with a melting ratio of 9 : 1. In ordinary foundry melting operations a loss of 5 per cent is probably correct on the average. Owing to careless weighing more iron often is taken out of the cupola than is charged and it is difficult to locate the trouble. The investigation which I made was on stove plate and I have no data on machinery casting losses. However, in a foundry making machinery castings the losses should be less than for stove plate, since the rust on the scrap and the sand on machinery castings is much less than on old or new stove plate and agricultural scrap. Machine-cast pig iron should show no loss in yard handling. During the year's operations some scrap pig is liable to be buried in the yard, which can be dug up at inventory time. However, you will find it very difficult to make your books balance on the total pig consumption and to balance the coke account is still more difficult. I find that if the accounts do balance, it is largely accidental. The class of men usually employed in the iron yard and on the charging floor makes accuracy difficult of attainment. In many foundries the coke is measured and is not weighed, while in some other shops the pig iron is not weighed.

THE FOUNDRY BEHIND THE AUTOMOBILE

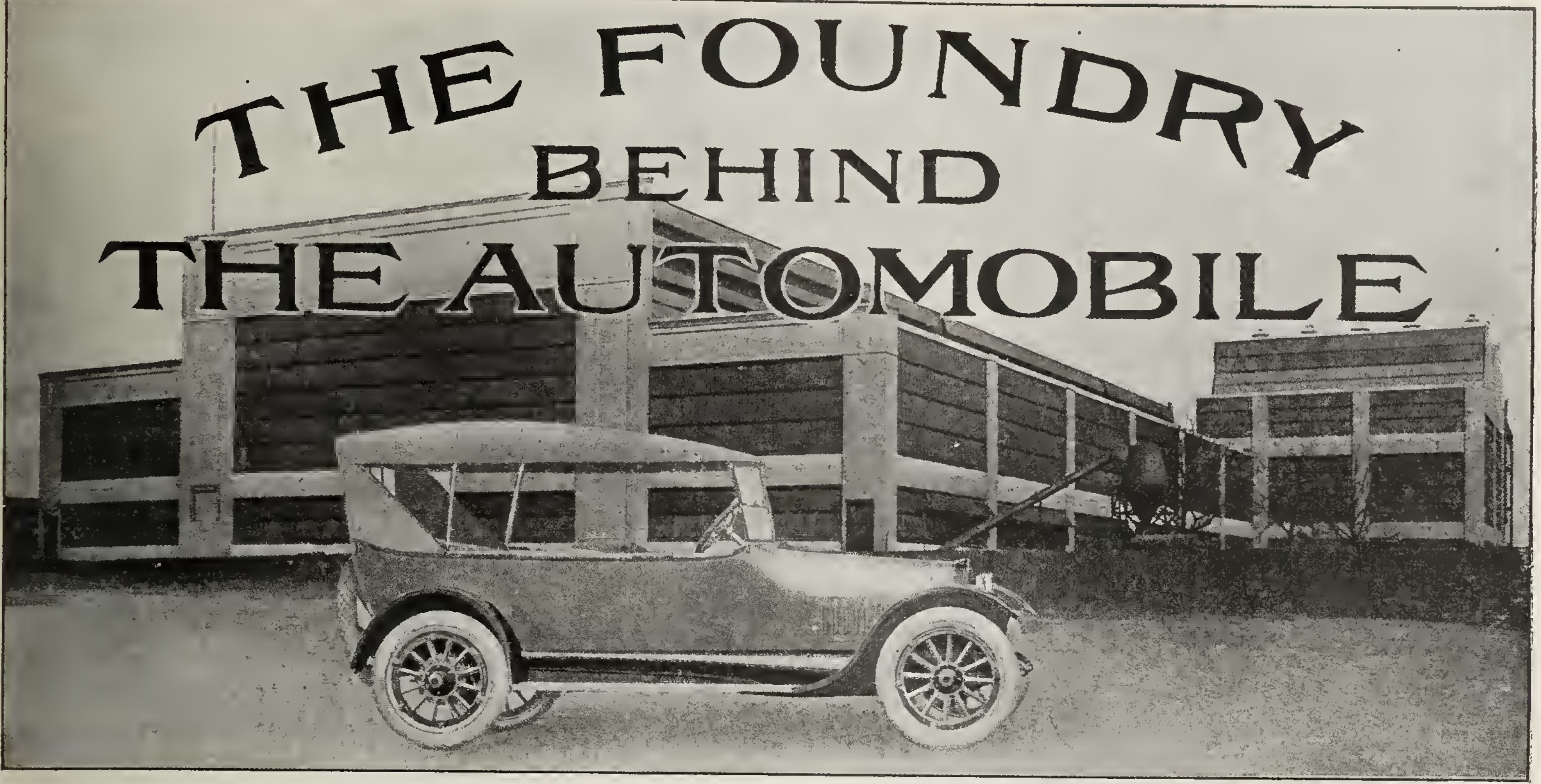


Fig. 1—Exterior view of the new foundry of the Buick Motor Co., Flint, Mich. The cupola bay is shown at the right

This Shop Will Melt 240 Tons of Iron Daily

WHEN John Houston Bardell, composite personification of thousands of owners of American-made motor cars, nanipulates the various push-buttons, evers, etc., which set his machine in notion, he little realizes that under he glossy hood of polished metal is wonderful mechanism, the achievement of science applied to industry. f Mr. Bardell would remove the hood, and could replace a section of the cylinder walls with a transparent material, he would be surprised at the terrific explosions which follow the ignition of the gas. Moreover, he would doubtless be alarmed if he realized that the force of these explosions is repelled by a thin shell of cast iron only 5/32-inch thick. If Mr. Bardell were an experienced foundryman, he would more fully appreciate the amount of study, experiment and effort that has been necessary to develop casting plants to the degree of perfection required to produce hundreds of cylinder blocks of unvarying quality from day to day.

The general public, Mr. Bardell included, is doubtless aware of the fact that behind the finished automobile is a wonderful organization and a well-equipped factory. The manner in

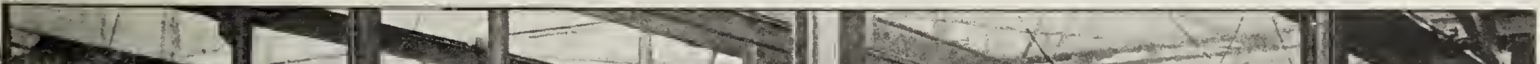


FIG. 2—THE MOLDING FLOOR IN THE BUICK FOUNDRY—NOTE THE SAND HOPPERS AND GRATES IN THE FLOORS

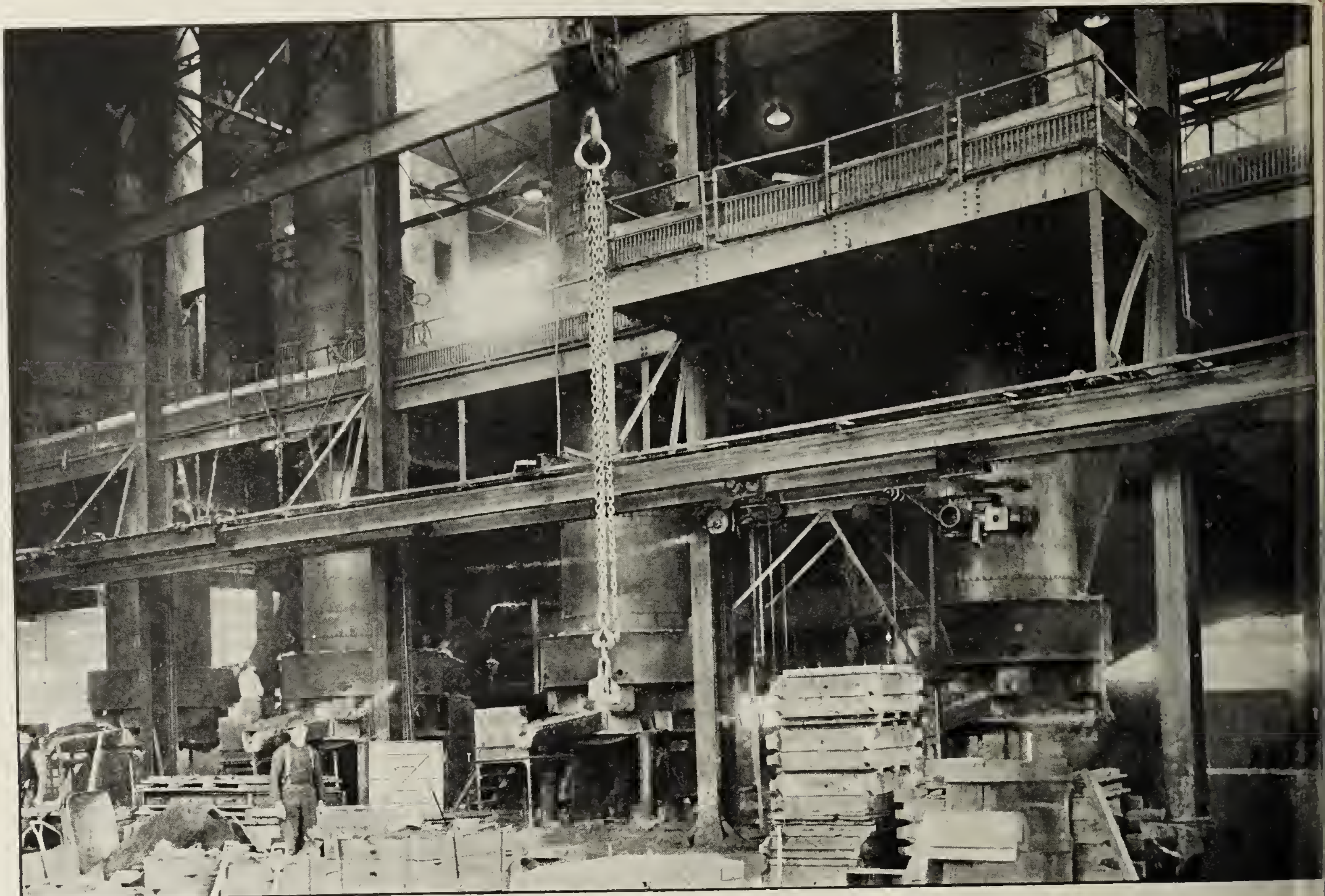


FIG. 3—FOUR OF THE CUPOLAS IN THE BUICK FOUNDRY—THE BLOWING EQUIPMENT IS ON THE FIRST BALCONY AND THE CHARGING PLATFORM IS DIRECTLY ABOVE

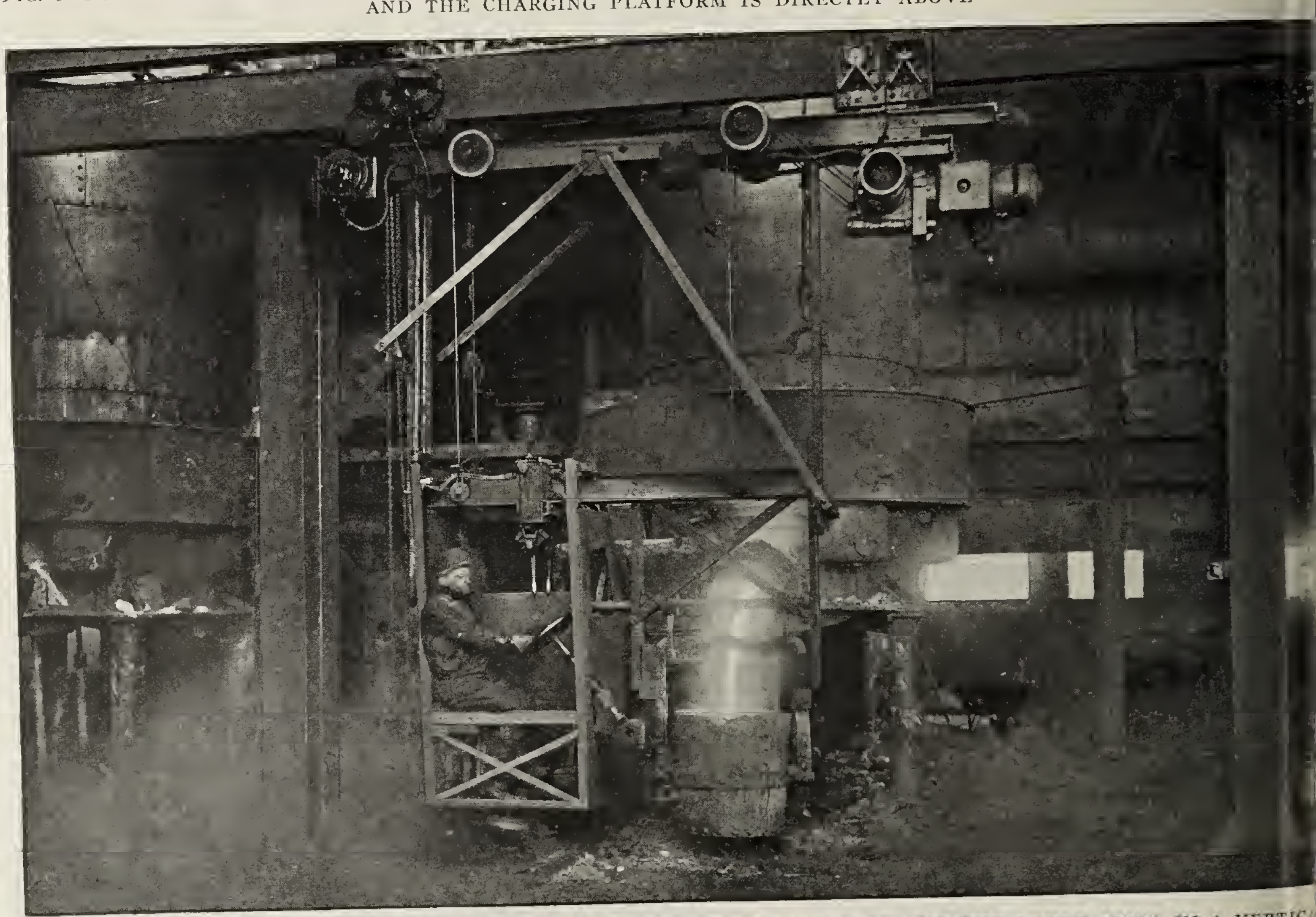
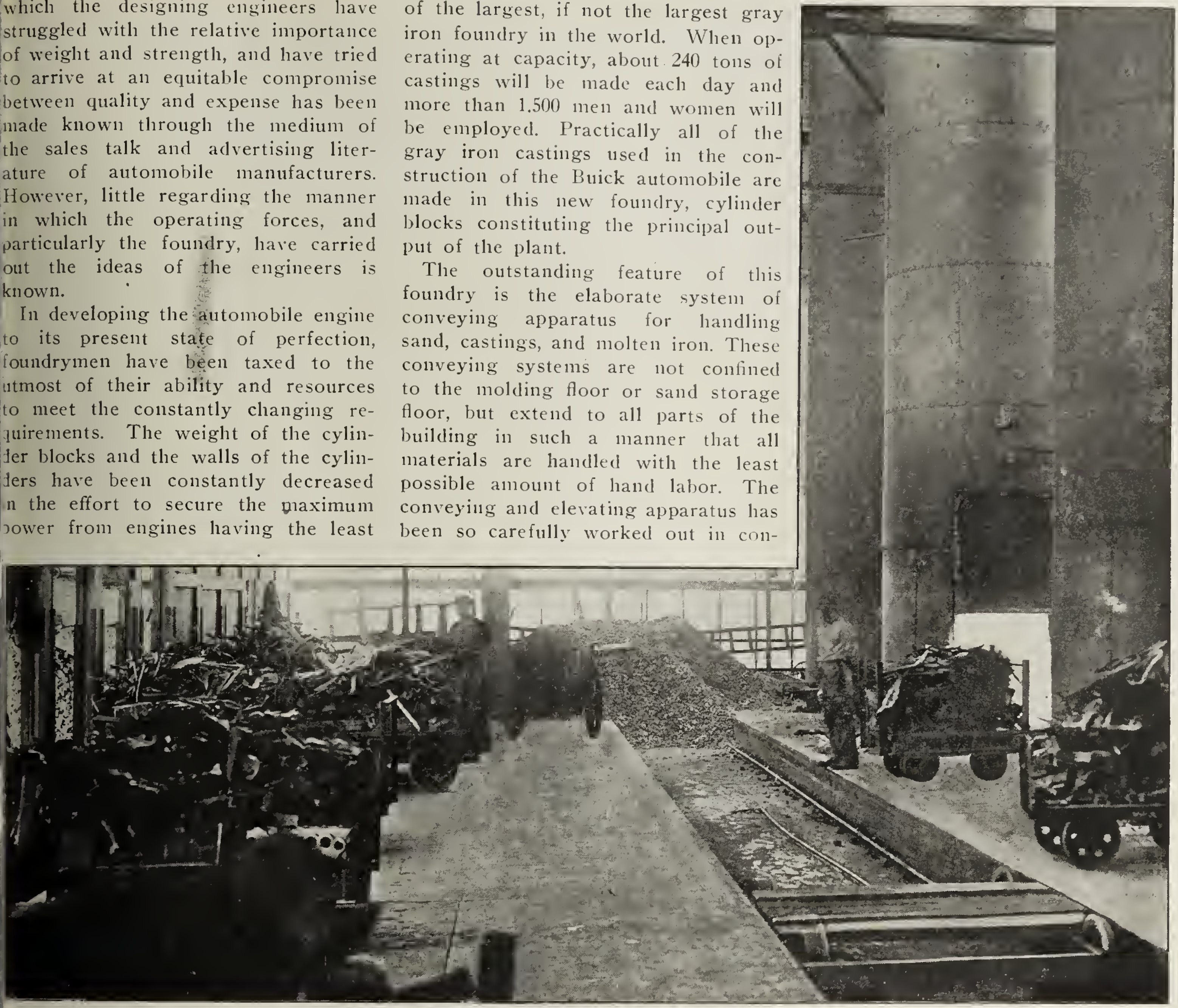


FIG. 4—TELPHER LADLE CARS OF UNUSUAL DESIGN—THE OPERATOR'S CAGE AND THE LADLE MOVE IN A VERTIC POSITION ALONG GUIDES, THUS ENABLING THE OPERATOR TO LOWER THE CAR FOR CHARGING AS SHOWN IN THE ILLUSTRATION

which the designing engineers have struggled with the relative importance of weight and strength, and have tried to arrive at an equitable compromise between quality and expense has been made known through the medium of the sales talk and advertising literature of automobile manufacturers. However, little regarding the manner in which the operating forces, and particularly the foundry, have carried out the ideas of the engineers is known.



IG. 5—A VIEW OF THE CHARGING FLOOR—THE TRANSFER TABLE ENABLES THE TRUCK OF MATERIAL TO BE MOVED TO ANY OF THE CUPOLAS

In developing the automobile engine to its present state of perfection, foundrymen have been taxed to the utmost of their ability and resources to meet the constantly changing requirements. The weight of the cylinder blocks and the walls of the cylinders have been constantly decreased n the effort to secure the maximum ower from engines having the least ossible weight. That foundrymen ave kept up with the ever-increasing ifficult requirements is only due to heir ability to improve the quality f the metal and to develop the methds of coremaking, molding and pourng to a point permitting the producion of hundreds of high-grade castngs each day. In order to accomplish his result, foundrymen have been bliged to bring into play a considrable amount of automatic sand and etal handling apparatus, molding achines, and intricate systems for onveying castings and materials in he foundry. In fact, the requireents of the automobile industry have reated a new kind of foundry which as many distinctive features not ound in other types of casting plants.

One of the best examples of the ew type of automobile foundry is the ew plant of the Buick Motor Co., lint, Mich. In addition to being one f the most modern casting plants of his kind, the Buick foundry is one of the largest, if not the largest gray iron foundry in the world. When operating at capacity, about 240 tons of castings will be made each day and more than 1,500 men and women will be employed. Practically all of the gray iron castings used in the construction of the Buick automobile are made in this new foundry, cylinder blocks constituting the principal output of the plant.

The outstanding feature of this foundry is the elaborate system of conveying apparatus for handling sand, castings, and molten iron. These conveying systems are not confined to the molding floor or sand storage floor, but extend to all parts of the building in such a manner that all materials are handled with the least possible amount of hand labor. The conveying and elevating apparatus has been so carefully worked out in connection with the design of the foundry building that its presence is not always conspicuous.

New sand is brought into the foundry on an 18-inch fibre belt, which travels near the ceiling of the first floor, as shown in Fig. 9. Wooden flange boards operated by ropes from below may be pulled down against the belt to divert sand at various points along the floor. The core and facing sands are directed to mixers made by the Standard Sand & Machine Co., Cleveland, where they are prepared for use. From the mixers, the sand is lifted to the second floor of the foundry, which is the molding floor, by means of elevators manufactured by the C. O. Bartlett & Snow Co., Cleveland.

The molding sand is handled on the first floor at the north end of the building. From here it is elevated to hoppers supported in the roof above the second floor by means of elevators built by the Palmer-Bee Co., Detroit. The hoppers have tapering sides and at the bottom divide into two rectangular-shaped chutes which straddle a monorail track. Specially-built telpher cars, constructed by the Sprague Electric Works, New York, are used to handle the sand. The sand is carried in a large, rectangular steel box attached to the telpher car and fits under the two chutes of the sand hoppers when in the filling position. When the car has been filled, the operator, whose cage is directly behind the sand box, moves the car along the monorail track to the point where the sand is to be discharged. The monorail track carrying the sand conveying telpher cars is directly over a two-rail track, on which a number of moving molding sand hoppers are situated. These hoppers have a rectangular-shaped opening at the top, which tapers down to a cylindrical body opened at one side at the bottom and securely bolted to a horizontal

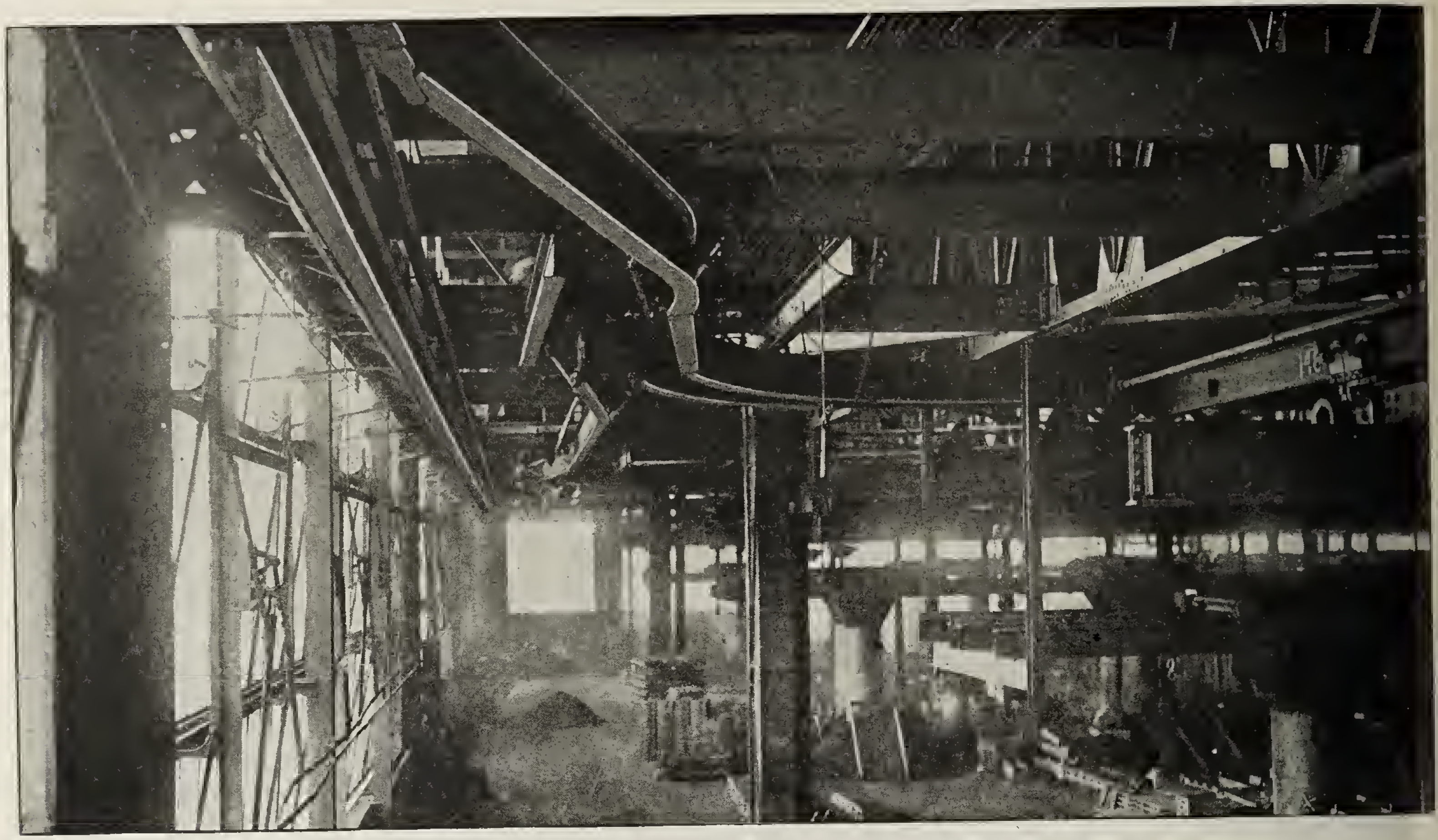


FIG. 6—A VIEW OF THE ROOF GIRDER CONSTRUCTION SHOWING THE ARRANGEMENT OF MONORAIL TRACKS AND SWITCHES

table, which serves as a floor for the hopper. When the telpher car operator has placed his car with the sand over one of these hoppers, he can release the sand by turning a hand wheel which opens drop doors in the bottom of the sand box. The falling sand rests upon the floor or the movable hoppers, where it is always within easy reach of the molders. Fig. 7 gives a view of one of these moving hoppers, and shows how conveniently the sand is placed at the disposal of the molders. Since these movable hoppers are suspended by four-wheel trucks on the tracks above, they may be easily moved along the molding bay to suit the convenience of the workers.

Reclaiming Sand

After the molds have been made, the metal poured, and the castings shaken-out, the sand is discharged through gratings in the floor onto sloping aprons, similar to *A*, Fig. 10, which direct the sand to the first floor of the foundry building. The arrangement of these gratings is such that the sand forms in long heaps in aisles on the first floor. These aisles are served by Sprague electric telpher cars, equipped with motor-operated grab buckets made by the Hayward Co., New York, which pass along the track, pick up charges of the sand and convey them to an aisle extending along the west wall of the first floor of the foundry building. Here the sand is directed to rectangular holes in the floor, which lead to rotary sieves, located in pits, about 10 feet below the floor level. As the sand passes through the sieves, the reclaimed sand drops onto one of the sand elevators, which carries it up to the hoppers above the molding floor, which already have been mentioned. The hard material separated from the sand, such as sprues, nails, wire, etc., which does not pass through the mesh, falls from the lower end of the open sieve into a receptacle at the bottom of a well served by a 1-ton Sprague Electric Works hoist. This material is easily brought to the level of the first floor by means of this hoist. In Fig. 13, the rectangular column at the right contains the sand elevator; the well and arrangement of the hoist is shown at the left.

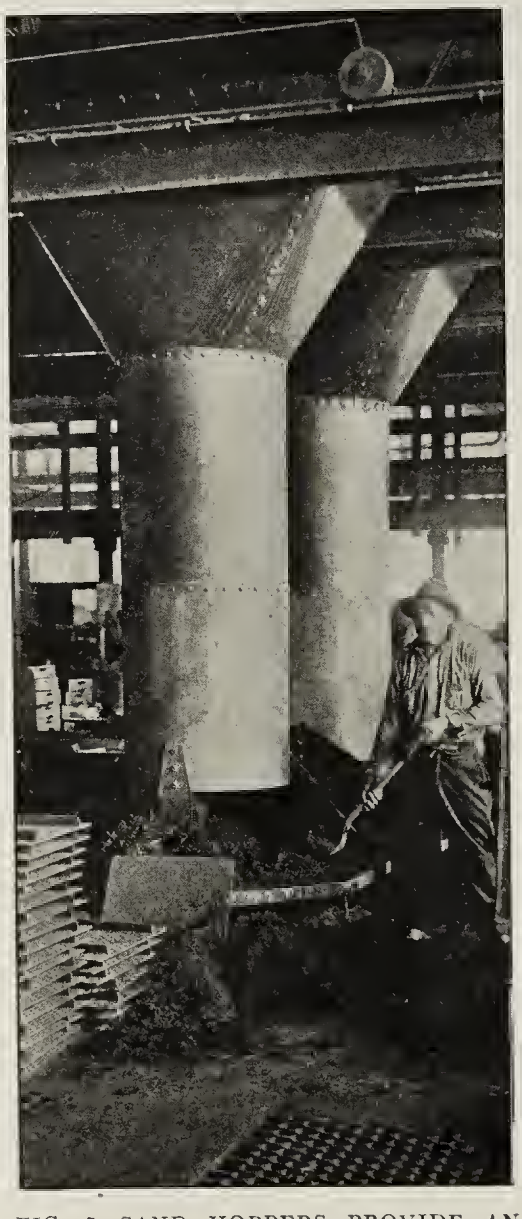


FIG. 7—SAND HOPPERS PROVIDE AN ADEQUATE SUPPLY OF SAND FOR MOLDERS AT ALL TIMES

Grades of Sand Used

Ohio sands are used for molding purposes and Michigan sands for cores. The core sand used is a mixture of one-half sharp sand and one-half bank sand. About 100 tons of core sand are used daily. The facing sand is a mixture of new sand, old sand, and sea coal, the ratio of sea coal to sand being about one to 16. Approximately 25 tons of new molding sand are used each day and the ratio of molding sand to iron melted is approximately one to eight.

The coke and pig iron storage yards are situated at the north end of the foundry building. The yard is served by a 20-ton crane made by the Pawling & Harnischfeger Co., Milwaukee. The materials to be charged in the cupolas

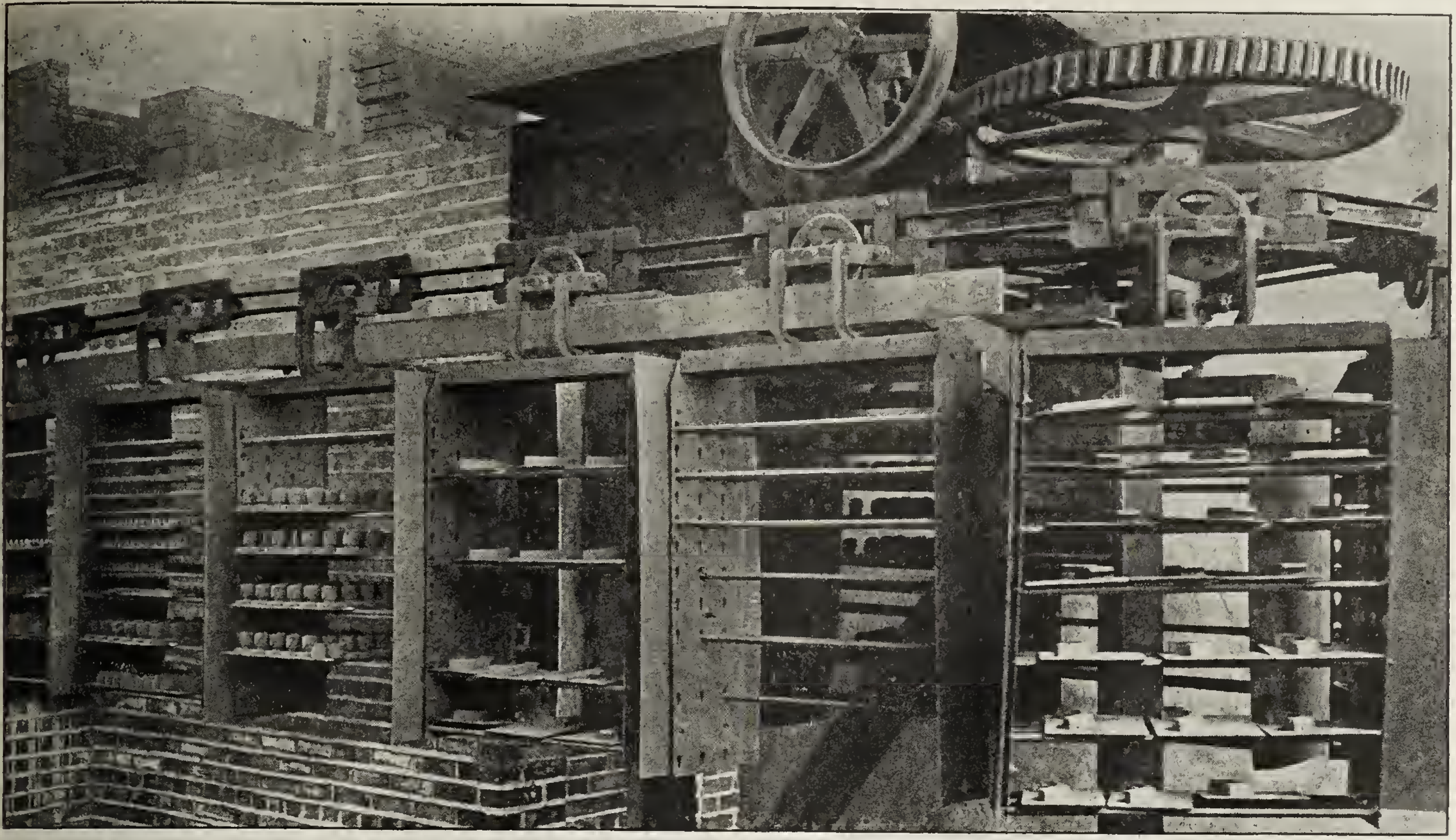


FIG. 8—SMALL CORES ARE BAKED IN A CONTINUOUS CORE OVEN WHICH CONSISTS OF AN ENDLESS CHAIN CARRYING CORE RACKS

are hoisted by means of this crane to a platform extending outside of the cupola bay of the foundry building. The charges are made up on small cars, which are pushed on small industrial tracks to a place near the cupolas. Here the weights of the various materials are checked by means of floor scales made by the Howe Scale Co., New York, and the Fairbanks Co.,. Broome, N. Y. The cars are then pushed onto a small transfer table, which runs on a wide track, paralleling the row of five cupolas. By means of this table, the cars may be transferred to any one of the five tracks on the cupola side of the depressed track. The charging platform is shown in Fig. 5.

How Sand is Stored

A sand storage building, 60 x 350 feet, is being erected north of the main foundry structure. The sand will be handled by means of a traveling crane and grab bucket. Provision is also being made for storing 2,500 tons of coke. The fuel will be carried to the charging floor by means of a skip hoist, operated by an electric hoisting engine on the charging floor.

The five cupolas, four of which were manufactured by the W. W. Sly Mfg. Co., Cleveland, and one by Byram & Co., Detroit, are situated in a specially constructed bay at the northeast corner of the foundry building. The four large cupolas, shown in Fig. 3, have 84-inch shells and are lined to an inside diameter of 60 inches. The equipment for supplying the blast for the cupolas is situated in a small balcony built at the back of the line of furnaces. The blast is supplied by a blower manufactured by the Piqua Blower Co., Piqua, O., driven by a 50-horsepower Allis-Chalmers motor, running at 865 revolutions per minute. The charging platform is directly above the motor balcony and the ground floor, charging platforms, and the balcony are connected by a large freight elevator, which assists in handling charging material, etc. As operated at the present time, two cupolas are alternated each day, but it is expected that in the near future three of the furnaces will be used daily. The cupolas are provided with blast meters, made by Charles J. Clark, Chicago.

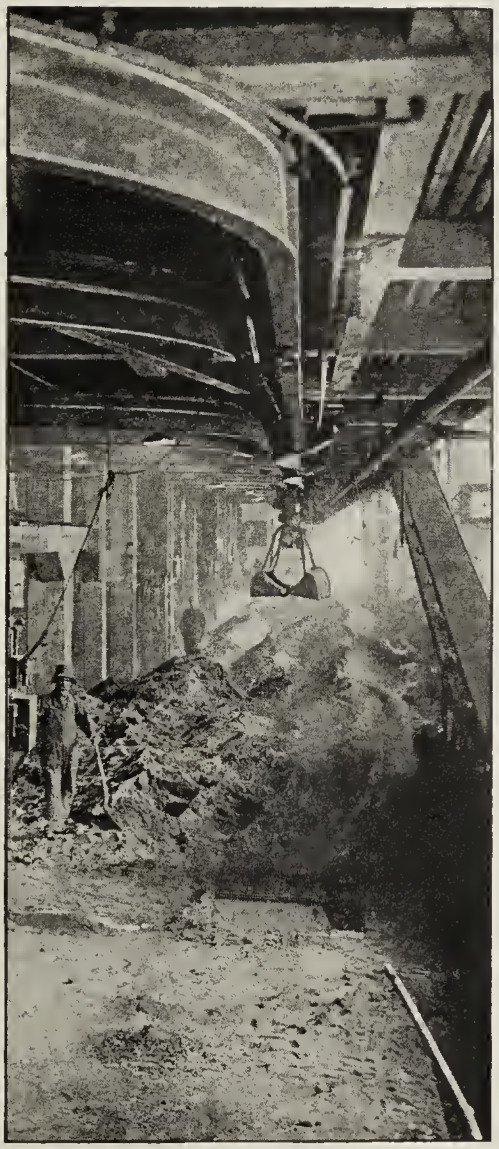


FIG. 9—AN AISLE IN THE FIRST FLOOR OF THE FOUNDRY BUILDING SHOWING THE MANNER IN WHICH SAND IS HANDLED

Handling the Molten Metal

One of the most interesting features of the new Buick foundry is the unique method of handling molten iron from the cupolas. The hot iron is tapped from the spout of the cupolas into 2-ton ladles carried in telpher cars of novel design. These cars, one of which is shown in Fig. 4, are suspended from the monorail track by means of double pairs of wheels. The operator's cage and the ladle are in reality, parts of an elevator which slides in vertical guides hung from the track. By means of a motor control, the operator may raise himself and the ladle from the lowest position, as shown in Fig. 4, to the running position which brings the elevator part of the car to a point near

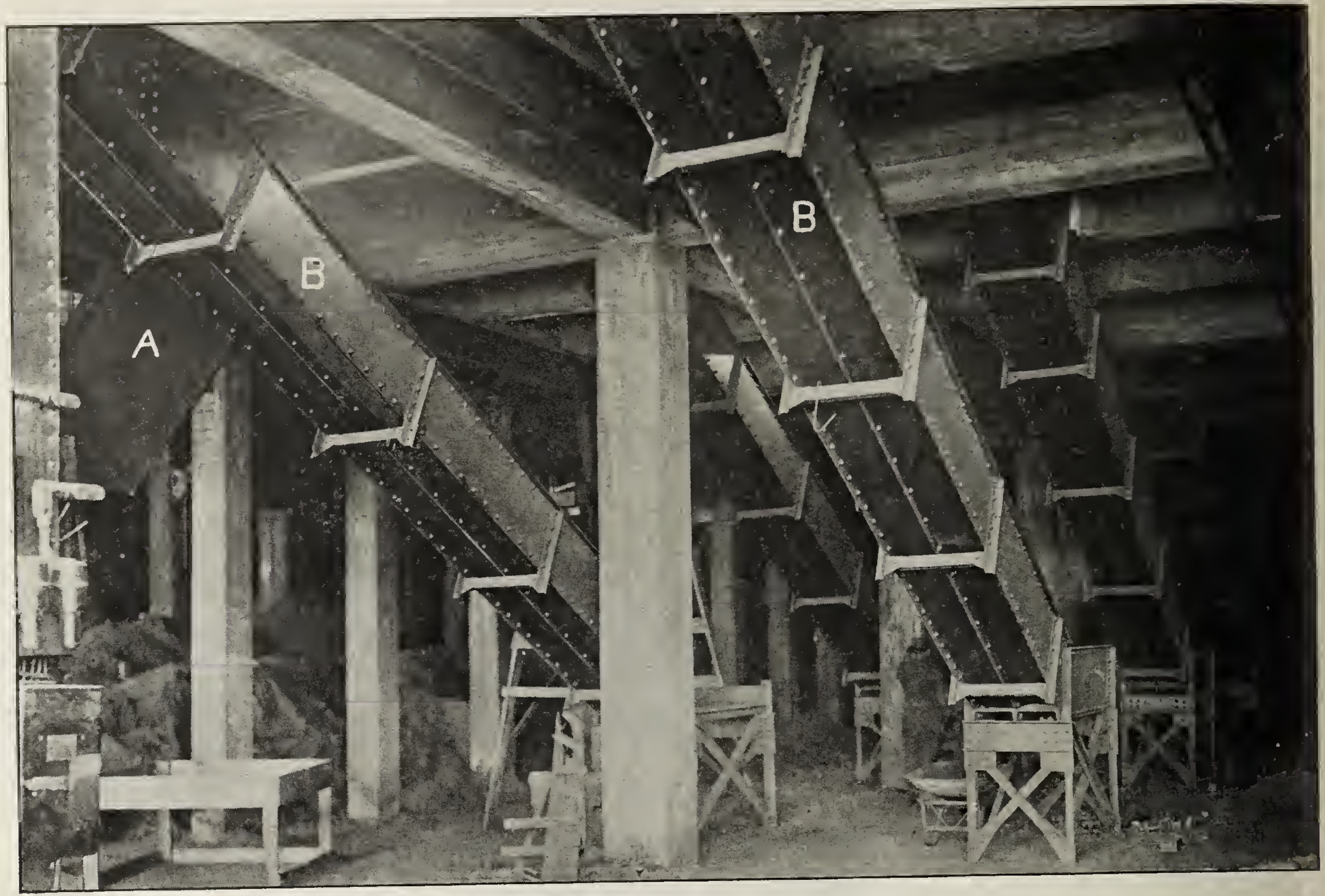


FIG. 10—APRONS AND CHUTES LEADING FROM THE SECOND FLOOR WHICH DIRECT THE SAND AND CASTINGS TO THE FIRST FLOOR

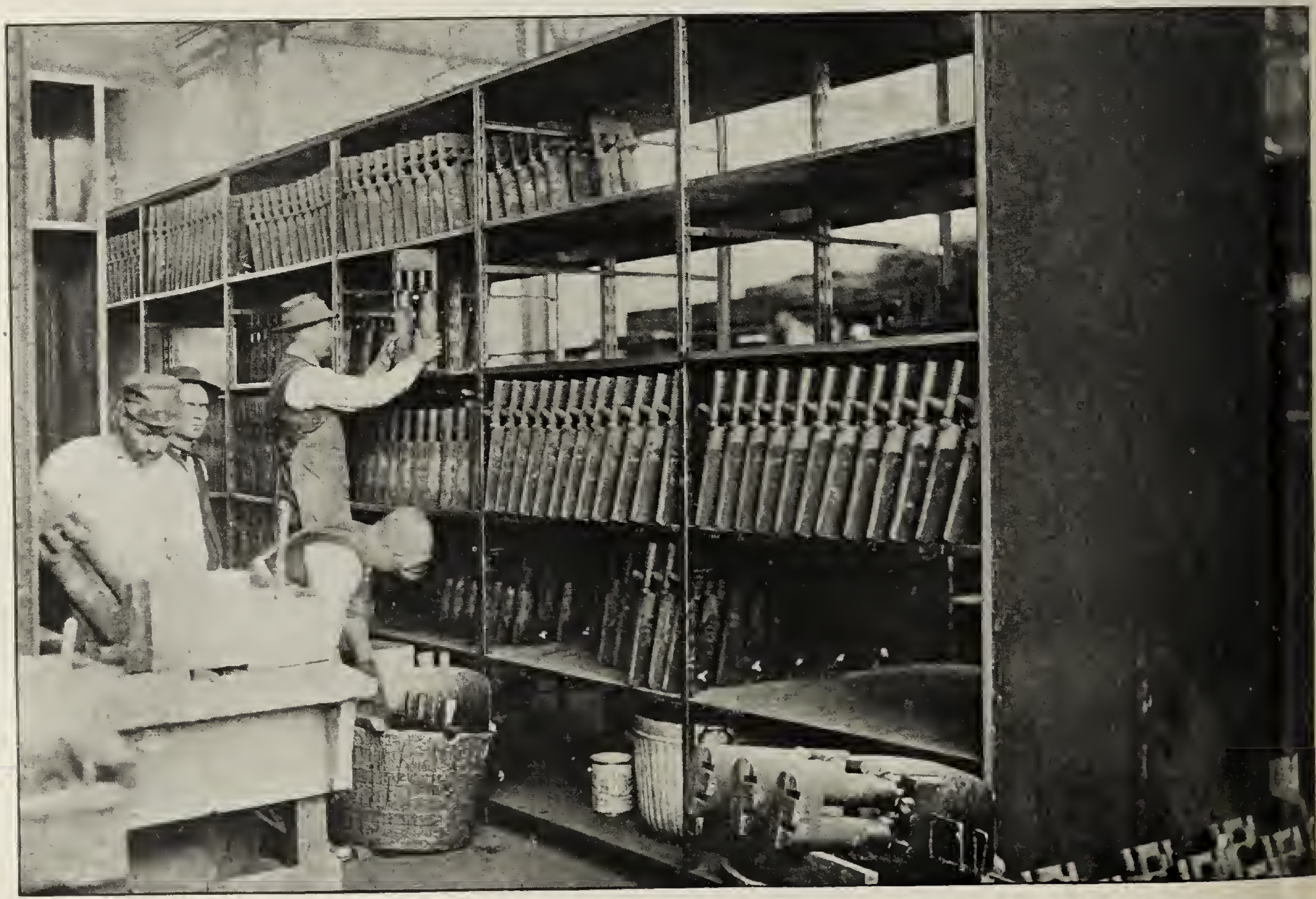


FIG 11—CORES ARE STORED IN STEEL RACKS—THE METHOD OF DIPPING CORES IN BLACKING ALSO IS SHOWN

the top of the guide, thereby allowing all parts of the car to clear ordinary objects on the molding floor. The ladle is tilted by the operator by means of a wheel which resembles in appearance and action the steering wheel of an automobile. When the operator of one of these cars approaches a cupola to secure a charge of metal, he lowers the elevator part of the car to the low position and then brings the ladle directly under the spout. After the ladle has been filled, he elevates the movable part of the car to the upper position and then proceeds to the molding floor, where he again lowers the elevator to a point near the floor so that he can tilt the ladle to pour the metal into the small distributing ladles handled by the workmen. The system of monorail tracks is such that a number of telpher ladle cars may operate without confusion, there being an adequate number of switches, and loops to enable the cars to circle about the cupolas and await their turn for metal. Fig. 6 gives an idea of the arrangement of the monorail tracks over a molding floor.

Molding Operations

Practically all of the heavy molding is done in the bay directly in front of the row of five cupolas. This portion of the foundry is served by a 10-ton electric traveling crane manufactured by the Pawling & Harnischfeger Co., Milwaukee, Wis. The first molding floor at the north end of the foundry is known as the cylinder bay. This molding floor is arranged with a broad aisle traversing the middle part of the floor and directly under the monorail track. On either side of the aisle are the floors where the molds are set up. The molding machines are arranged on either side of the cylinder bay and are supported on heavy concrete bases which extend from the floor of the molding room through to the first floor and to solid ground. This form of construction was necessary to minimize the vibration set up by the molding machines. The other molding bays are arranged in a manner similar to that of the cylinder bay. The principal types of molding machines used in the new Buick foundry are power jar, power roll, power draw machines, made by the International Molding Machine Co., Chicago; power jolt, hand draw machines, made by the Arcade Mfg. Co., Freeport, Ill.; power jar, power roll, power draw machines, made by the Osborn Mfg. Co., Cleveland, and electric jar machines made by Henry E. Pridmore, Chicago. At the present time the molding floors are operated 10 hours a day. Molding begins at 6 a. m., the first metal is poured at 6:30 a. m., and at 7 o'clock the first castings are shaken-out. At the present writing the daily output of the Buick foundry is about 150 tons, but it is expected that within a short time the full capacity of the plant, which is about 240 tons a day, will be reached.

The daily production consists of approximately 650 motor castings, although the regular molding schedule calls for something over 800 motors a day. The specifications call for cylinders having walls only 5/32 inch thick. In order to withstand the high pressure of explosions, a special mixture of cast iron is used. About 12½ per cent of steel is added to the

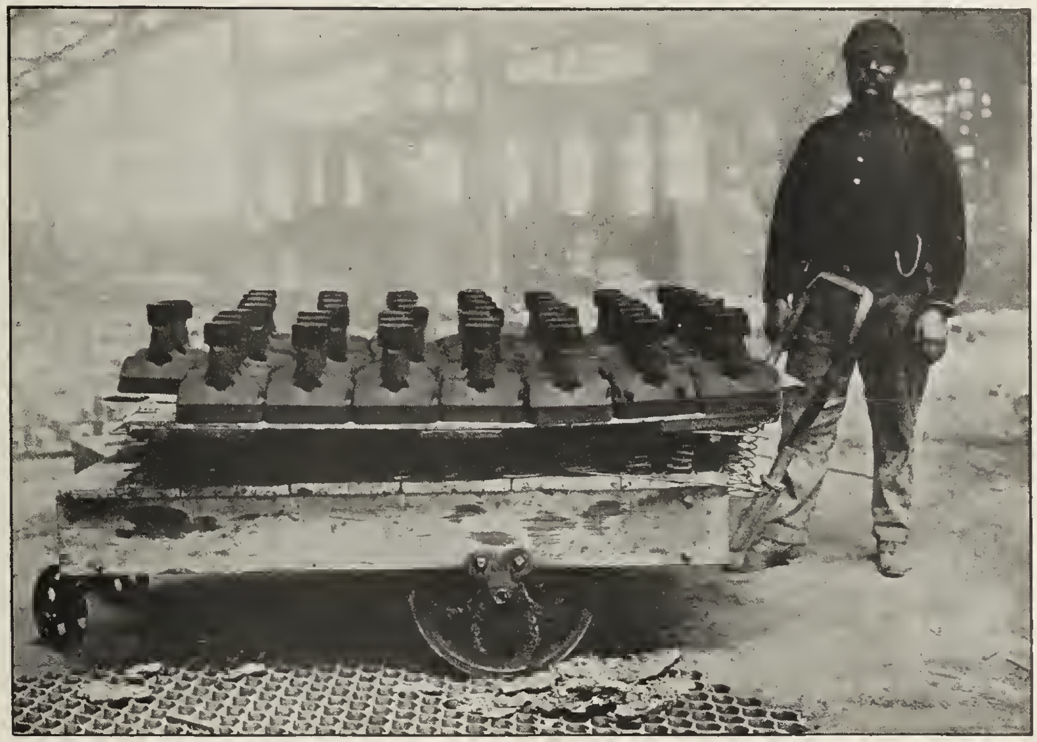


FIG. 12—JARS FROM THE TRUCK ARE PREVENTED FROM AFFECTING THE CORES BY MEANS OF THE BED SPRING SHOWN IN THIS ILLUSTRATION

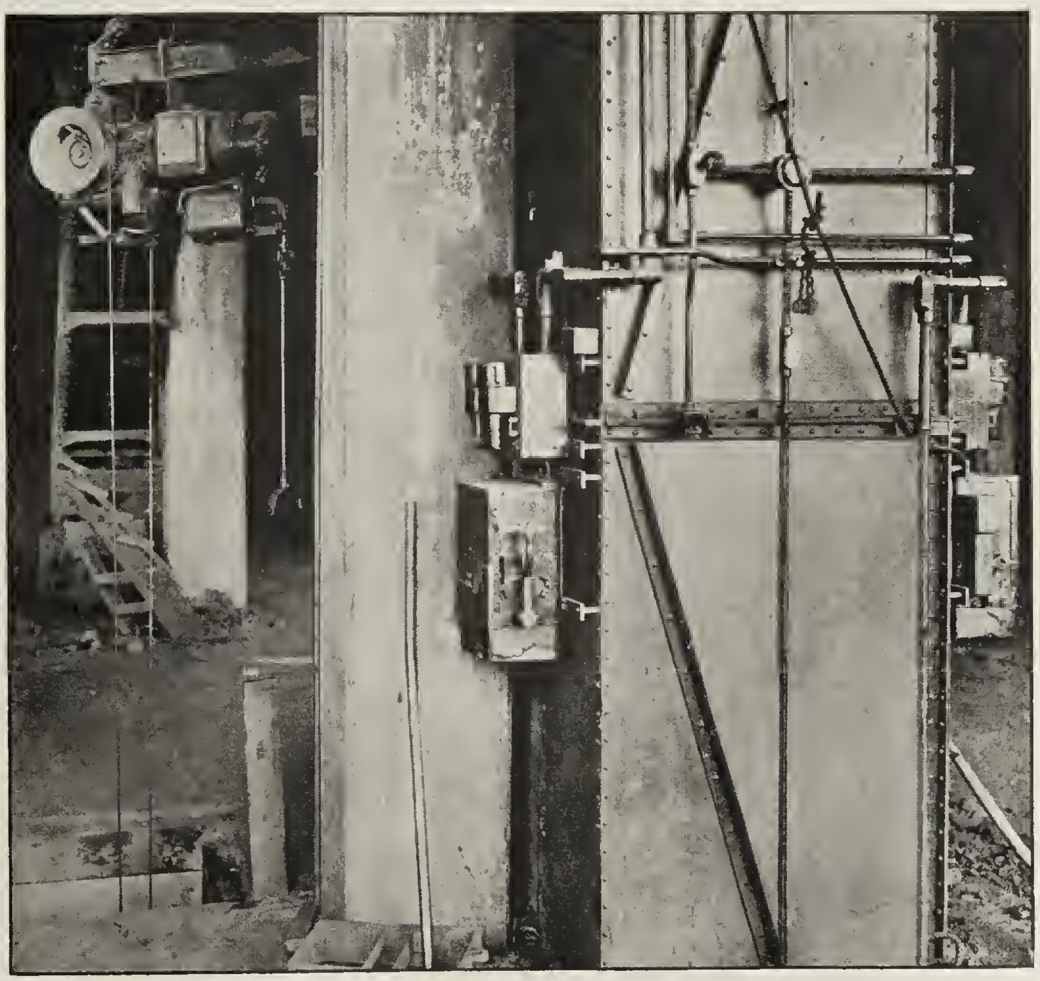


FIG. 13—THE BOX-SHAPED COLUMN AT THE RIGHT CONTAINS THE MOLDING SAND ELEVATOR; OTHER MATERIALS WHICH DO NOT PASS THROUGH THE SIEVE ARE HANDLED BY MEANS OF THE ELECTRIC HOIST SHOWN AT THE LEFT

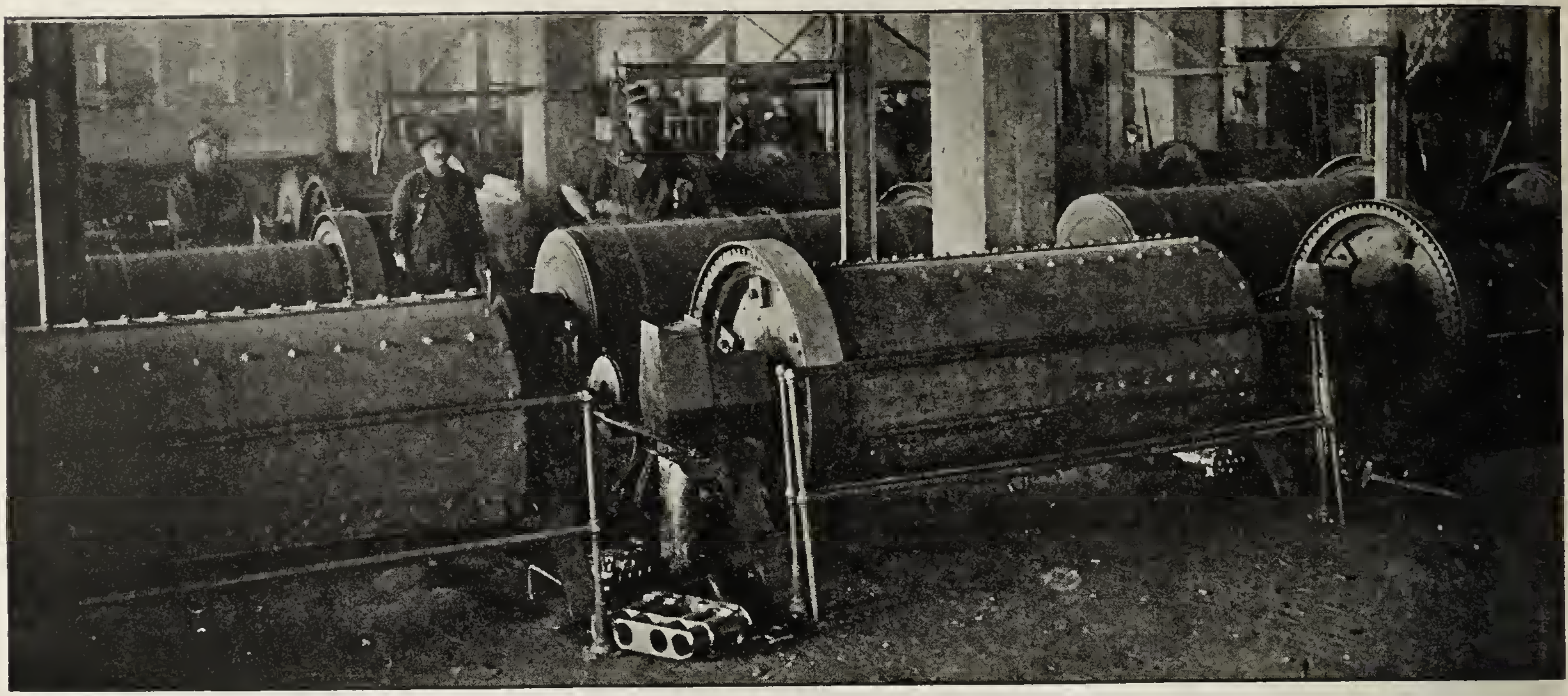


FIG. 14—A VIEW IN THE CLEANING ROOM SHOWING THE UNUSUALLY LARGE NUMBER OF TUMBLERS USED

mixture. A special grade of low phosphorus iron is used and the resultant metal contains from 2.15 to 2.25 per cent of silicon and the usual amount of sulphur and manganese. Tests of the metal are made hourly and a Keep machine is used to determine the strength of test bars. The strength of the ½-inch test bars, on the average, is about 550 pounds.

Making the Cores

The core room in an automobile foundry is one of the most important factors involved in its success. In the new Buick plant an unusually large amount of floor space has been allotted to the core department. The machine, core oven, and storage equipment is situated in the south end of the building on the second floor. At the southwest corner is a large room, in which 75 women are engaged in making cores.

The methods employed in the core department of the Buick Motor Co. are unusual and extraordinary precautions are taken to insure perfect cores. After the cores have been made, they are smoothed-up to exact size in rubbing jigs. They are then taken to finishers, who scrape them. After the cores are finished in this manner, they are taken to the assemblers, and are then oven-dried and inspected.

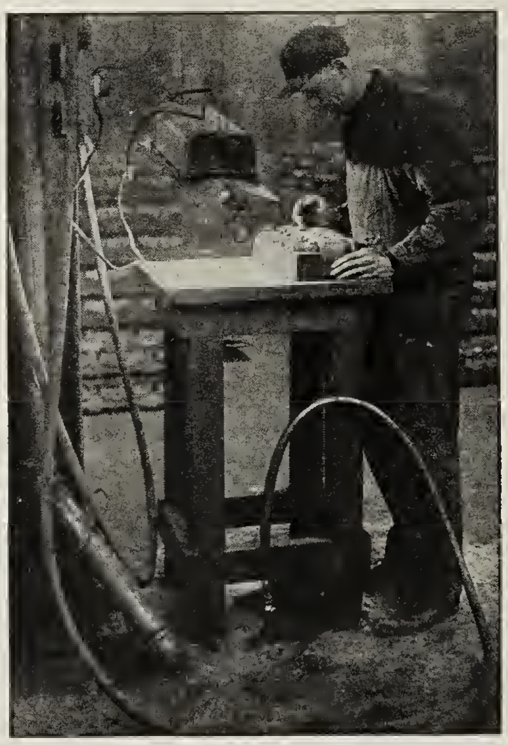


FIG. 16—CORE INSPECTION TABLE

Core Shop Equipment

The core oven equipment is unusually extensive, including a conveyor type of oven made by William Demmler & Bros., Kewanee, Ill., and eight-drawer and 24-car type ovens designed by the H. M. Lane Co., Detroit. The continuous conveyor oven is shown in Fig. 8. Cores to be baked are placed on steel racks, which are handled by storage battery charging trucks made by the Automatic Transportation Co., Buffalo, N. Y.,

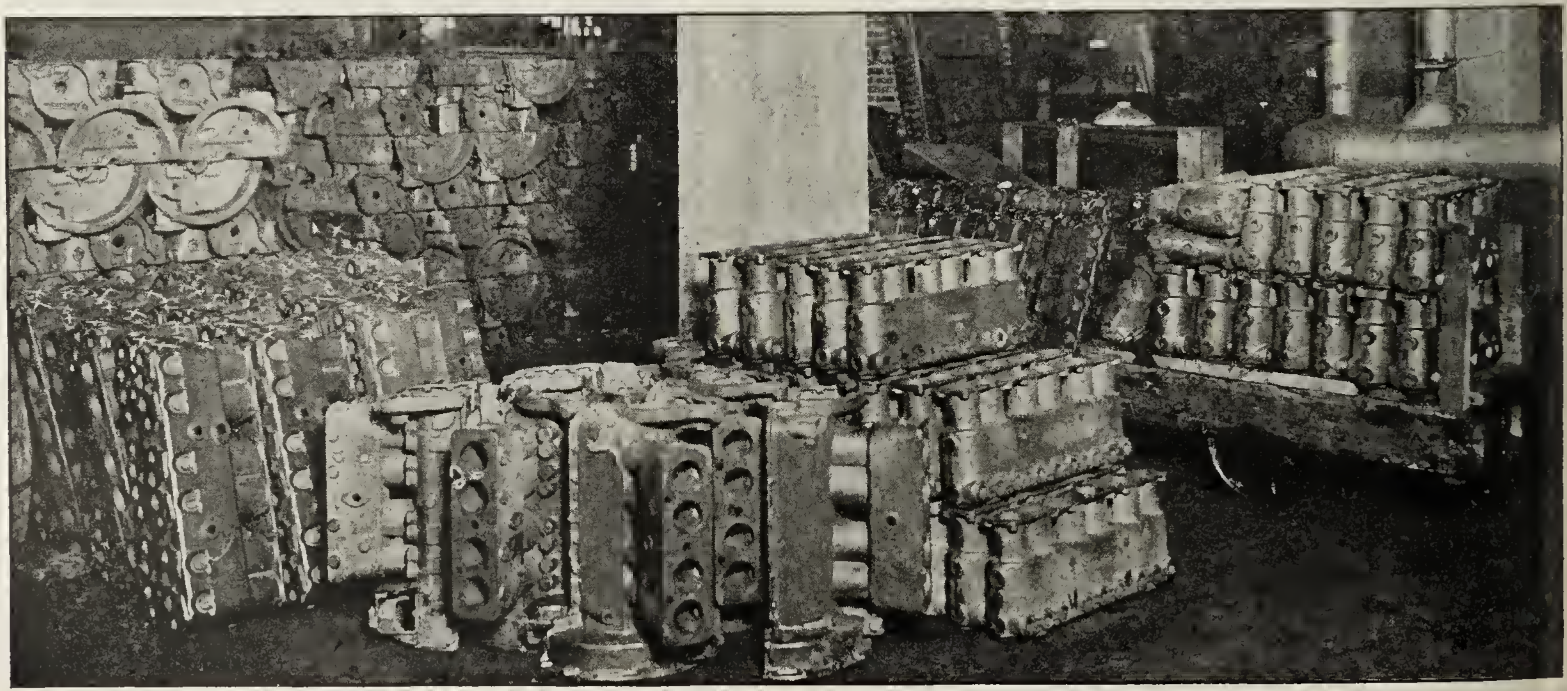


FIG. 15—A CORNER OF THE SHIPPING ROOM SHOWING A LARGE NUMBER OF MOTOR CASTINGS READY FOR SHIPMENT

and the Elwell-Parker Electric Co., Cleveland. Heat for the car and drawer type core ovens is furnished by means of furnaces situated in the basement under the first floor. These furnaces, which were designed by the H. M. Lane Co., Detroit, are coke-fired and supply a large volume of hot air, which is maintained at a constant temperature of 450 degrees Fahr. The core ovens are equipped with electric pyrometers made by the Brown Instrument Co., Philadelphia.

As the cores pass from one stage of completion to another, they are frequently stored on steel racks manufactured by the Durand Steel Locker Co., Chicago. These lockers are clearly shown in Fig. 11, which also indicates how the cores are dipped for blacking.

The finishing and inspection of certain kinds of cores is greatly facilitated by means of the inspection table, shown in Fig. 16. It will be noted that the lamp, which is made by the Cooper Hewitt Electric Co., Hoboken, N. J., throws a white light directly upon the work, enabling the inspector to easily detect defects in cores. The air hose shown in the illustration is provided for blowing loose particles of sand from the recesses of the cores.

Fig. 12, which illustrates the type of hand truck used in conveying cores from the core room to the molding floor, indicates how the common bed-spring has been utilized advantageously in the foundry. It was found that in carrying cores on trucks, the jolting resulting from the pounding of the wheels on the hard floor, had a detrimental effect on the cores. To overcome this difficulty, the bed-springs were introduced, and the upper tables, on which the cores rest, were prevented from swaying sideways by means of wooden guides placed at either end of the trucks, as shown in the illustration.

Shaking-Out the Castings

After the molds have been prepared, the cores placed in position, and the metal poured and set, the sand is shaken-out. The castings are lowered through rectangular holes in the molding floor, which open into a number of chutes, some of which are shown at *B, B,* in Fig. 10. These chutes lead to benches built about 2 feet above the first floor, as shown in the illustration. As the castings slide to these benches, they are placed in large, rectangular-shaped boxes, which are later carried to the cleaning room by means of telpher cars.

The cleaning room occupies the southeast corner of the first floor of the foundry. The equipment in this department is unusually extensive and modern, and includes about 20 cylindrical tumblers of large size, seven smaller cylindrical tumblers, six tumblers of the box type, and four horizontal table sand blast machines, all manufactured by the W. W. Sly Mfg. Co., Cleveland. Dust arresters for the cleaning room apparatus were installed by the W. W. Sly Mfg. Co., and by the Central Iron Co., Quincy, Ill. The grinding equipment consists of a horizontal grinder, made by the Gardner Machine Co., Beloit, Wis.; a number of double-stand grinders, made by Frederick B. Stevens, Detroit; grinders made by the Detroit Emery Wheel Co., Detroit, and a number of swing grinders. The tumbler equipment is served by 2-ton electric hoists made by the Sprague Electric Works, New York, and pneumatic hoists made by the Curtis Pneumatic Machinery Co., St. Louis, Mo. Fig. 14, which is a view of the tumbling equipment, shows the extensive amount of apparatus required in the cleaning department.

After the castings have been thoroughly cleaned, they are placed on test racks and subjected to hydraulic pressure for leaks. The handling of the castings to and from the test racks, is facilitated by gravity carriers made by the Mathews Gravity Carrier Co., Ellwood City, Pa. After the test, the castings pass to the southwest corner of the foundry building, which serves as the shipping department. Fig. 15 shows a group of automobile castings ready for shipment.

It will have been noted in reading the foregoing account of the equipment and features of the Buick foundry that this plant has been especially designed for the mass production of castings in an economical manner. That good lighting and ventilating was an important consideration, is indicated in Fig. 1, which clearly shows the concrete and steel construction and the large proportion of the side and end walls consisting of steel sash. The roof construction is of the type know as the Pond truss, in which the cupola takes the form of the letter *M*. It will be noted that the wide span of the building has the effect of making the M-shaped cupola of unusually large dimensions, enabling the design and construction of three tiers of permanent sash in the cupola walls. These sash are operated by means of special sash operating gears shown in a number of illustrations containing interior views of the foundry. The Pond truss, the steel sash and operating gear were manufactured by the David Lupton's Sons Co., Philadelphia.

The floors are concrete throughout, except some portions of the cleaning room on the first floor, which are made of creosoted wood blocks. The building is heated by means of radiators placed at convenient points on the walls and ceiling. The radiator equipment was manufactured by the American Radiator Co., Chicago. Artificial lighting on the second floor is provided by means of Cooper Hewitt lights arranged twelve in a row across the building. Incandescent electric lamps are used in other parts of the building. The plans for the new foundry were suggested by members of the Buick Foundry staff and by the H. M. Lane Co., Detroit. The plans were executed by the H. M. Lane Co., and the construction work was done by the A. J. Smith Construction Co., contractor.

Government Prices for Zinc

The following prices for slab zinc have been fixed by the zinc committee of the advisory commission of the Council of National Defense and have received the approval of the government: Grade A, 11½ cents per pound; grade B, 11 cents, and grade C, 9 cents. The price of grade C is protected against decline. These prices are in carload lots, with freight allowed to New York delivery rate points. At the time when these prices were made, grade A sold in the open market at 18 cents and grade C has sold as high as 27½ cents per pound during the past year.

Rennerfelt Furnaces Sold

The sale of 17 additional Rennerfelt electric arc steel melting furnaces is reported by Hamilton & Hansell, New York City. One of these furnaces will be installed by the Central Steel Co., Massillon, O., for melting ferro-manganese, which will have a capacity of one ton and a 1,000-pound furnace was sold to the Chili Exploration Co., New York City. The remaining 15 furnaces are for installation abroad.

The Foundry Appliances Co., Newark, N. J., has been incorporated with $15,000 capital to engage in the manufacture of foundry appliances and supplies. Ernest M. Tapner, Newark; Charles J. Helligas, East Orange, and Joseph D. Louden, Rozelle, are the incorporators.

The American Foundry & Equipment Co., Chicago, has been organized with $10,000 capital, by Richard Fitzgerald, J. C. Schwartz and L. J. Bretz.

R. B. Seidel, Inc., Philadelphia, manufacturer of crucibles, is making plant extensions at a cost of about $3,000.

The Electric Furnace in the Steel Casting Plant

Details of the Practice Pursued in the Foundry of the Michigan Steel Castings Co., in the Production of Parts Averaging About 20 Pounds

By R F Flinterman

“SMALL Steel Castings” is the term applied to castings used for the most part for automobile trucks, tractors, light machinery parts, and for other purposes, where the size and shape of the part, its lightness of section or difficulty of production preclude its being made practically in open-hearth foundries. In the latter, the work is largely a tonnage proposition. The work is much heavier and on the whole simpler and the methods used cannot be applied successfully to the manufacture of lighter and more intricate castings.

The castings made in the plant of the Michigan Steel Castings Co. vary in weight from ½ to 250 or 300 pounds. Some pieces running up to 2,000 pounds are made; but the average weight is about 20 pounds.

Before installing the electric furnace a crucible furnace was used. This was chosen because of the low first cost of installation and also because of the generally accepted fact that crucible castings were of very high quality.

Crucible Process

The great difficulty with the crucible process was in the crucibles themselves. An average of three heats was considered good and at that rate meant about one cent added to the metal cost. Many crucibles would not come up to this average, and in order to save them as much as possible the final addition of ferro-silicon and ferro-manganese was cut down to a minimum. The result was a steel of low manganese content, about 0.4 per cent, and as a consequence a steel which was not always deoxidized. The inability to keep the carbon low, because of the absorption of carbon from the crucible was an added aggravation.

The second method was the side-blow converter. Its advantages over the crucible are:

Large unit of capacity, converters of one-ton and two-ton capacity being used.

The metal was uniformly hot and fluid and of fairly regular analysis.

Possibility of increasing manganese content and consequently getting very much better results on physical tests.

Great reduction of metal cost. The cost varied little from month to month.

The third and likely final choice was the electric furnace. The first furnace, a 6-ton Heroult, was installed in November, 1915. The second furnace of 3 tons capacity was ready to run Feb. 12, 1916. Both furnaces have been running continuously since their installation. It required several months to adapt the electric furnaces to shop conditions. This has, however, long since been accomplished and the furnaces have come up to expectations most completely.

Quality of Electric Steel

As regards the quality, the author believes that there is no question of the superiority of electric steel. In the converter at the end of the blow there is a mass of metal at a high temperature, covered by a highly oxidized slag and the metal itself undoubtedly contains oxides. The addition of ferro-silicon and ferro-manganese at this point deoxidizes the metal more or less completely, but the metal is still in contact with a slag carrying a high percentage of iron oxides, etc.

In the electric furnace the covering slag is completely deoxidized before ferro-silicon and ferro-manganese final additions are made. The metal is constantly giving up oxides to the slag during the deoxidizing period and is practically free from oxides before the final deoxidizers are added.

It is thought that the more complete absence of oxides in the electric steel accounts for its superiority. The results obtained on physical tests are universally better. Typical results are as follows:

	1	2	3	4
Max. strength, lbs.	66,750	76,000	62,400	69,000
Elastic limit, lbs..	42,500	45,000	36,500	37,800
Per cent reduc. in area	51.7	45.8	50.0	40.0
Per cent elongation in 2 inches......	35.0	30.0	32.0	28.0
Silicon	0.23	0.20	0.27	0.33
Sulphur	0.025	0.021	0.043	0.050
Phosphorus	0.044	0.040	0.036	0.056
Manganese	0.74	0.64	0.52	0.70
Carbon	0.19	0.23	0.19	0.24

Steels Nos. 1 and 2 are from the basic furnace and Nos. 3 and 4 are from the acid furnace. The basic steel averages slightly higher than the acid steel.

The superiority of the electric steel lies in the fact that these results can be consistently obtained from every heat which was never possible in our other practice. Physical tests have been made on 30 consecutive heats and for every heat we have obtained results corresponding to the tests given. With the converter steel difficulty was experienced in maintaining an average reduction of area of 25 per cent and the elongation was usually about 20 per cent.

The superiority of the electric steel was also manifested in the case of long, thin-section castings, such as cross-members on engine supports. The loss due to shrink tears was much reduced with electric steel. On one particular pattern 100 castings were made from electric steel and no shrink tears were found. With exactly the same practice and pattern, 90 out of 100 castings made from converter steel had slight tears or cracks, which had to be welded in order to save the castings. This particular casting was very difficult to make and was perhaps an extreme case, but the test made brought out this difference in behavior most vividly.

Low Sulphur Content

This behavior is due to the lower sulphur content of electric steel and the absence of impurities, particularly of oxides. This resulted in much greater strength at high temperature and this greater strength was able to resist the pull, exerted on the steel during that period, when the castings were shrinking or shortening. This behavior of electric steel was true with both acid and basic steel, particularly with the latter, when a lower sulphur could be maintained.

It was particularly pleasing to have the high quality steel without any increase in cost. Under present market conditions, with low phosphorus pig iron selling at an exorbitant price, electric steel can be produced at a lower cost than with the use of this pig. As practice improves, electric steel manufacturers feel that their product can compete with that of any other process, under normal market conditions.

From a paper presented at the meeting of the American Electrochemical Society at Detroit, May, 1917. The author is president and general manager of the Michigan Steel Castings Co., Detroit.

At the present time the Michigan Steel Castings Co. is using acid linings and bottoms entirely. The reason for abandoning the basic process was the high and prohibitive price of magnesite. The company was a new consumer for this refractory and had not been able to secure a large supply, since the dealers were loathe to take on new customers and it became necessary to resort to acid practice.

This experience has been most valuable since one very great advantage was found in the acid process. One great difficulty with the basic process is the slag. The metal was poured from the furnace into a large coffee spout ladle in which the metal was taken to the pouring floors. The metal was poured through a spout into hand shanks, from which it was poured into molds. In all cases the metal was skimmed by means of a metal rod skimmer, while it was being poured into molds, in order to keep all slag back and prevent its entering the molds. In spite of all precautions there was much more trouble from slag in the castings than we had ever had from converter steel.

With exactly the same methods this slag trouble disappeared with the change to acid steel. This was due to the greater refractoriness or higher melting point of the siliceous slag, which brought about a more complete separation of the slag from the metal.

The basic metal acted at times as though there were actually present in the metal a small amount of slag in solution which slag would finally separate as the metal lost its heat. In a number of tests which were made when special precautions were taken to remove slag from metal, during the pouring of molds, we still found slag spots on the machined surfaces of the castings.

Reversed Duplexing Process

As already stated, with acid steel there was a minimum of slag trouble. This has led to the conclusion that an ideal arrangement for a steel foundry would be to use a "reversed duplexing process", as it were. Part of the metal should be melted in a basic furnace, where the metal would be refined and sulphur and phosphorus eliminated in the usual way. The stock used in this furnace should be of a much cheaper grade and would more than offset the increased cost of rehandling the refined metal through the acid furnace as the next step in the operation.

In the meantime, the acid furnace has been working on a partial charge of steel, to which when molten will be added the refined metal from the basic furnace. The final deoxidation under an acid slag can then be completed and metal withdrawn in the same manner as is done now. The author believes fully that this "reversed duplexing" can be so timed and manipulated in two or more furnaces that the ultimate output of the battery of furnaces will be the same in any given period as though the furnaces were all running either basic or acid independently.

Advantages of Duplexing

This method of "reversed duplexing" would have the following distinct advantages for the producer of steel castings:

1. The cost of part of the raw material would be much lower, since a high sulphur and high phosphorus stock can be used, as for instance screw machine turnings, which bring a low price on the market and cannot be used in acid practice.
2. The basic furnace could be run at a lower temperature during refining period and the life of roof and walls would be much prolonged. The final temperature could be attained in the acid furnace, where there is no difficulty in securing necessary temperature and fluidity without injury to lining. We have run up to 300 heats without repairing roof or lining.
3. It would be possible to obtain lower sulphur and phosphorus in the acid steel without increase in cost, in fact the finished cost might even be less.
4. The metal would receive final deoxidation under an acid slag. The advantage of this acid slag has already been emphasized, particularly the fact that the slag is more refractory and separates more completely. There is one further advantage. When the furnace contents are poured into the large ladle, the latter is immediately covered over with a congealed heavy slag crust, which keeps the air away from the steel and also keeps the steel hot longer. This is of great help in pouring a large variety of small castings, when fluidity and high temperature are most essential.

The author believes this "reversed duplexing process" may be of great value in other products such as tool steel, piano wire, etc., where the absence of even minute slag particles is most desirable. It would be interesting to conduct a comparative test on the products named above, made in the ordinary way and made by this double process. The suggestion may not seem so far-fetched when one bears in mind the fact that the higher grades of steel wire were until very recently made by crucible process, and in this process the slag was essentially an acid slag. How much of the quality possessed by these steels was due to the acid slag?

One other advantage of the electric furnace should be mentioned, namely, its great usefulness in making any of the alloys. This has been demonstrated by the constantly increasing adoption of the electric furnace by tool steel producers and other makers of special steel. This same advantage can also be put to use by manufacturers of steel castings in the production of alloy steel castings.

The author's experiences in making alloys by other processes was most unsatisfactory, since we were unable to obtain consistent results. This was due, no doubt, to the highly oxidized slag and presence of oxides in the steel itself, so that in many cases the alloying metals were oxidized and would be present in the final metals in varying and diminished quantities. With the electric steel the results have been more gratifying. We have been able to obtain any desired analysis regularly, and in consequence the subsequent heat treatments have given us the high physical qualities which we were after. This opens up a large new field for the maker of small castings, since there is a large demand for alloy castings for certain purposes, where lightness and great strength and thoroughness are necessary.

Every producer of steel castings wishes that this might be true. Without doubt the electric steel is purer and in consequence has within itself a minimum of impurities which during the transition from the molten state to a solid mass, would assume a gaseous form and cause blow-holes. This much is granted as true. But, nevertheless, there is just as much cause for presence of blow-holes in electric steel where the metal is poured into molds, as when the metal is made by other methods. The cause for such blow-holes is not inherent in the steel itself, but is due to the methods of making the molds and preparing them for the steel.

Importance of Molding

Just as much care must be used in molding to make a good casting, in order to maintain in the casting the high quality and strength possessed by the electric steel. Perhaps even greater care and vigilance must be used because of the very high temperature at which the steel is delivered from the electric furnace.

The electric furnace is not a cure-all for all foundry woes and troubles. To make a superior casting, the electric furnace metal must have a perfect mold, prepared with every possible care and attention to detail, properly gated, properly fed and properly vented. When such a happy combination has been properly brought about, the resultant casting will be satisfactory.

THE BRASS FOUNDRY

A Difficult Bronze Casting Molding Job

By Charles Vickers

ANY bronze or copper casting that is chambered-out by a relatively large core having few and small prints, is difficult to make. As a rule, the pattern is not constructed to facilitate molding in a way that will insure a sound casting and, furthermore, more than the ordinary amount of skill and planning ability is required to obtain satisfactory results.

The casting to be described is a water-cooled ring that constituted a part of the equipment of an electric furnace. Several brass founders failed in its production because they insisted on molding it the way the patternmaker thought it should be made, with the outlet cores in the drag of the mold. One foundryman tried the job seven or eight times before he gave it up as a failure and there is little doubt but that he could have made seven or eight more attempts with the same result, had it been possible to allow the pattern to remain with him that long. This reference is not made with the view of casting reflections upon this foundryman, but to dissuade others from trying to handle castings of this type in this manner.

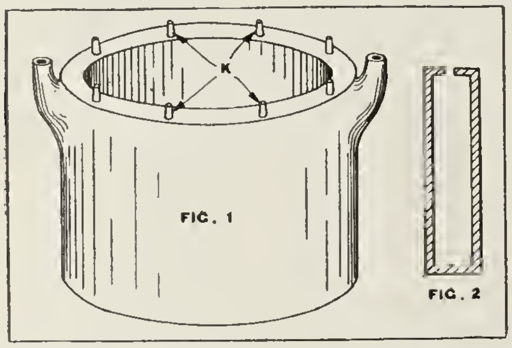


FIG. 1 — PATTERN FOR A BRONZE, WATER-COOLED RING. FIG. 2—CROSS-SECTION SHOWING RELATIVE METAL THICKNESS

The pattern is illustrated in Fig. 1, one of the cores in Fig. 3, and Fig. 2 is a cross-section of the casting through one of the vents. The two curved projections on the pattern are the water inlet and outlet; the small prints, *K*, Fig. 1, are ¾-inch in diameter and constitute the only means by which the core can be secured and provide the only outlet for the gases from the main core. The body core was made in four segments, one of which is shown in Fig. 3. These were provided with interlocking joints, two segments having the tongue on the inner part of the circle and two cores with the tongue on the convex side. The tendency of the four segment cores, when set in the mold, was to spring outwards. This was counteracted by a wire hoop bound around the body core and recessed into a groove. This tied the four segment cores into a strong, rigid ring. The wire is shown at *M*, Fig. 4, which is a diagonal section of the mold and clearly shows the runners and runner basins.

Patternmaker's Molding Method

The patternmaker planned to mold the casting with the prints, *K*, Fig. 1, in the drag, and the pattern was made and drafted accordingly. The first foundry that attempted the job experienced trouble from the start. Undoubtedly good castings can be made from the pattern as designed, nevertheless, the odds are overwhelmingly in favor of failure.

Let us consider what occurs in such a mold when the metal begins to enter. It fills the bottom in the form of a ring, encircling the slender core prints; fresh, hot metal continues to flow against them and as it rises it presses against the lower surfaces of the cores, and if these yield only slightly, the core rises and the metal flows around and underneath the core prints and up into the vents. The outlet for the gases is closed immediately, and as they gather force, disaster ensues. If the segment cores are held down by wires extending through the prints and are fastened to tie rods in the body of the core, there is always a chance that the fastenings may become loose, the tie rod used as an anchor may yield, or the wires may stretch under the strain. If the amount of yield is only 1/64-inch, the casting is a failure and is scrapped. It is possible, of course, to hold the cores rigidly with wires and chaplets. In this case the vents are free, but are necessarily small to conform to the size of the prints. Then, if the metal is poured strongly, it rises around the core faster than the gases can escape downwardly through the small prints and some are trapped in the upper part of the core and escape through the core and through the metal thickness in the upper part of the mold. This results in a blown casting. If, on the other hand, the mold is poured slowly, some part may fail to run. We have made out a pretty bad case for this particular method of molding, but it is not exaggerated, as those who have had this sad experience know.

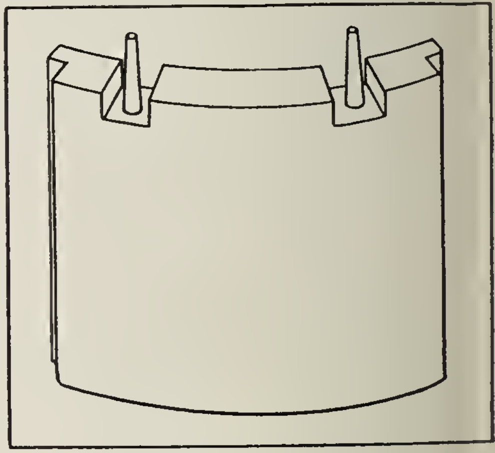


FIG. 3—ONE OF THE FOUR CORE SEGMENTS

The most satisfactory way to mold this casting is to suspend the core, as shown in Fig. 4. The core segments were suspended by thin wires which were doubled and one end of each was anchored securely in the core around the tie rods; the other ends extended up the vent channels in the main and small outlet cores, and projected about a foot beyond. The cores were made from an oil sand mixture, were well vented with cinders and were blacked with plumbago.

As the inside of the ring was lifted in the cope, it was necessary to pro-

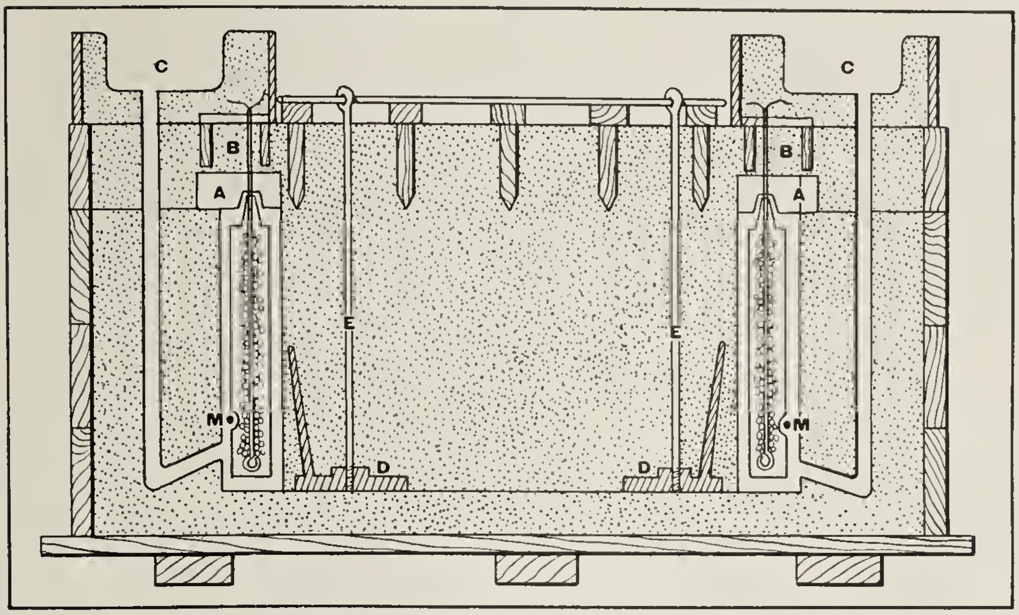


FIG. 4—DIAGONAL SECTION OF THE MOLD FOR THE BRONZE, WATER-COOLED RING, SHOWING THE METHOD OF GATING AND MOLDING. THIS RIGGING PREVENTED THE SHIFTING OF THE CORE

vide a lifting ring, *D*, Fig. 4, to which prongs were attached to hold the sand at the sides; the lifting rods, *E*, were screwed into lugs cast onto the lifting ring. The upper ends of the lifting rods were provided with screw-eyes through which a bar was passed and wedged underneath, on top of the flask bars, as shown. In this way the mass of sand, from the cope bars to the bottom of the ring, was securely held.

After the rigging was made, the actual work of ramming the mold was simple. A two-part flask was used, which consisted of a 6-inch cope and a deep drag. The pattern was placed core prints down on the follow-board, the drag flask was lowered, rammed and rolled-over and gates were provided in each corner of the mold. The outside of the ring was molded entirely in the drag with the joint flush with the upper part of the pattern, but the inside of the ring was parted at the bottom so that the green sand core formed part of the cope. The core was secured to the cope by the lifting ring and the screw-eyes. The cope lift was perfect, which was facilitated by the draft of the pattern which had been designed for molding the opposite way. However, in spite of this disadvantage, it would not have been possible to have obtained this result if the making of the mold had been in less skillful hands.

After the cope was lifted off, it was placed on high trestles so that the molders could work underneath, and the suspended green sand core was blacked and slicked, after which the core segments were placed in position. They were suspended by thin, double wires anchored in the body of the core, which passed up through the vents in the small cores that formed the outlets for the gases.

The ring core was held down with brick cores, *A*, Fig. 4, set over the core prints when molding the cope. The rectangular holding-down cores were recessed to fit over the core prints of the pattern and had vents passing through the top of the recess. They were rammed-up in the cope and were properly secured against a drop-out. When the ring core segments were set, the suspending wires were threaded through the vents in the holding-down cores and through the rest of the cope, having been secured to a rod laid across the flask bars by passing the wires on either side of it and twisting them together on top. The four core segments were bound together by a wire which was recessed in circumferential groove filed into the core, as shown at *M*, Fig. 4. The groove was filled with plumbago paste and the core was warmed with a gasoline torch. There was very little work to do on the drag after the pattern was drawn, except to black, slick and clean it out. The cope was tried on before permanent closure, but as everything had been planned carefully, there were no unforeseen occurrences. The mold was ready for the metal at the minute that had been specified, and there was no necessity for *holding* the metal in the furnaces. About 800 pounds were required to pour this casting. A ladle that held about 600 pounds and which was handled by a hoist, supplied the greater part of the metal. This was poured through one of sprues, while the opposite sprue was served by a crucible which held about 200 pounds of metal. While pouring, the runner basins, *C*, Fig. 4, were kept partially full of metal, and when the mold was filled they were about half full. No risers were provided and none were necessary. The metal in the basins was broken away while hot and after a suitable interval, the cope was removed and revealed what proved to be a perfect casting. This job again proved that careful planning and rigging are essential to foundry success, resulting from good molding practice. The work was done by William R. Marr, proprietor of the National Bronze Foundry, Niagara street, Buffalo.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Mine Pump Impellers

We would like a brass mixture suitable for brass impellers for mine pumps subjected to the corrosive action of mine water. We have been using a mixture consisting of 75 copper, 20 tin and 5 zinc, but this did not serve our purpose.

We believe the alloy would be too brittle for successful use in impellers. Zinc should not have been added to such an alloy, as it is impossible to obtain homogeneous metal with the percentage of tin stated. An alloy consisting of copper, 79.75 per cent; 15 per cent phosphor-copper, 0.25 per cent, and tin, 20 per cent, should be substituted in all cases where a hard mixture is desired that must sustain a high compressive load.

For bronze impellers we suggest the following alloy: Copper, 40.17 per cent; zinc, 37 per cent; tin, 0.25 per cent; 30 per cent manganese-copper, 17 per cent; nickel, 3.58 per cent, and aluminum, 1 per cent. Melt the copper, nickel and manganese copper together under charcoal, add the aluminum and stir thoroughly; follow with the zinc and the tin.

If a copper-tin alloy is preferred to the foregoing, use the following: Copper, 89.50 per cent; phosphor-copper, 0.50 per cent, and tin, 10 per cent.

Utilizing Scrap Babbitt Metal

We have accumulated about 600 pounds of cheap babbitt metal, which will grade about No. 4, and a small lot which will grade No. 1. We would like to make a good grade of babbitt metal from this material and we would like to have you advise us how we should proceed with this mixture. Also we would like to cast stock bushings for automobiles from red brass and we would like to know whether it is necessary to use a dry sand mold or whether a permanent mold is employed. The bushings are to be 1-inch outside diameter with a ½-inch hole bored in the center, and 12 inches long, while other bushings are to be 1¼ and 1½ inches in diameter with ½-inch openings.

The only satisfactory method of converting the babbitt metal is to melt it, mix it thoroughly and make an analysis of the ingoted metal. From this analysis the desired formula may be obtained accurately. Any other method is guesswork and would lead to inferior results.

The stock bushings will have to be cast in sand molds made by a skilled molder. The permanent mold cannot be used to advantage in making such castings and we do not advise such experiments on account of their high cost. It is not necessary to use a dry sand mold since the ordinary method of green sand molding will yield excellent results. The cores must be stiffly rodded to prevent bending them by the hydrostatic pressure of the metal. The castings should be poured horizontally and should be gated at a number of points so that the metal will positively fill the mold.

Difficulties in Casting Bronze Bushings

We are experiencing some difficulty in casting bronze bushings, which develop pit holes after cleaning, some of which extend into the metal as deep as ⅛-inch. These bushings are 2 inches in diameter with a 1-inch core, 1½ inches in diameter with a ¾-inch core, 1 inch in diameter with 1½-inch core and 12 inches long. They are molded vertically and are poured from the top through one gate. The metal was melted in a 40-pound pot in a coke-fired furnace and was kept covered with charcoal. The metal was ready to pour in 1¾ hours after the fire was started. We use a mixture of salt and borax as a flux and skimmed the metal once when in the fire and twice after its removal. We believe that this pitting is due to oxidation, but we are unable to trace the cause. Kindly let us know whether the time of melting has anything to do with our trouble.

The time of melting will not affect the quality of the metal provided it is protected from oxidation during the time it is in the fire. We fail to connect the pitting of the surface of the castings with the oxidation of the metal and we believe it to be due more probably to the use of molding sand of a poor quality and ramming the mold too firmly. Better results would be obtained by molding the bushings so that they can be cast on an incline with the gate at the upper end, the core being made rigid by a stiff iron rod embedded therein; the cope and drag of the mold should be thoroughly vented by the use of a knitting needle after ramming and before the cope is removed.

Bronze Mixture to Resist Acetic Acid

Kindly furnish us with a bronze mixture which will resist the action of acetic acid. The castings are to be used for bungs for vinegar barrels and the mixture, therefore, must contain no ingredient which will form a chemical reaction with the vinegar.

Any alloy containing copper, in time, will be attacked by the acid, resulting in the formation of copper acetate. If bronze must be used in this case, the following alloy might be employed if not too expensive: Copper, 90 per cent, and tin, 10 per cent. The castings should be coated heavily with tin on the surfaces exposed to the action of the vinegar.

Analyses of Bearing Metals

We would like to have analyses of four anti-friction bearing metals to be used for the following purposes:

Heavy duty and high speed engines, motors and generators, for passenger and freight car service, etc.

Heavy duty and low speed bearings, such as are used on rolling mills, heavy duty, low speed engines, rock crushers, etc.

Light duty and high speed bearings for cream separators, automobiles, aeroplanes, small motors, blowers, grinders, planing mill machinery, etc.

Light duty and low speed; these bearings are intended as an ordinary metal for light, low speed machinery.

The following alloys, in the order in which the inquiries are made, will meet the requirements stated:

Tin, 83.5 per cent; antimony, 11 per cent, and copper, 5.5 per cent.

Tin, 60.75 per cent; antimony, 10.5 per cent; lead, 25 per cent, and copper, 3.75 per cent.

For the last two classes of bearings, the following will give good service:

Lead, 80 per cent; antimony, 15 per cent, and tin, 5 per cent.

Utilizing Thin, Rolled Brass Scrap

What mixture is used by mills for rolling sheet brass 0.01-inch in thickness and less? How can this brass be used in the form of scrap approximately ½-inch wide?

The composition of sheet brass may vary widely within a range of 60 per cent copper and 40 per cent zinc, to 88 per cent copper, 10 per cent zinc, 1 per cent tin and 1 per cent lead. Its composition depends entirely upon the purpose for which the brass is intended. In this instance it would be safe to assume that the brass consisted of 70 per cent copper and 30 per cent zinc and that it can be used to advantage on this basis for adding zinc to any alloy of which this metal forms one of the ingredients. Also, it could be used for making yellow brass to which it would be advisable to add 2 pounds of tin and 2 pounds of lead to each 100 pounds of brass, in order to stiffen it and make it machinable.

Owing to the small particles constituting the scrap, it will almost be necessary to briquette it, as otherwise much of it will be lost in charging it into the crucible or furnace. The size of these briquettes will be governed by the manner in which the scrap can be used; if it is to be run down into yellow brass a large briquette can be used and a smaller one will be necessary if the brass is employed to carry zinc into a red brass alloy. If a cabbaging press or briquetting machine is not available, it is advisable to run the scrap into ingot molds, provided a large crucible is at hand for this purpose, as this thin scrap can be handled with a scoop shovel to fill the crucible after which the furnace can be closed to soften the scrap; after the scrap is softened it can be crushed down, fine charcoal added and more scrap charged, and this operation can be continued until the pot is full, when it can be pulled and the metal poured into ingots of suitable size.

White Brass for Automobile Door Handles

Can your furnish us with a mixture of white brass which is used at present for automobile door handles?

The following alloy is used extensively for this purpose: Copper, 49.85 per cent; nickel, 15 per cent; zinc, 35 per cent, and aluminum, 0.15 per cent. Melt the copper and nickel together, add the aluminum and stir well, following with the zinc. The latter is added gradually to avoid chilling the molten bath.

THE FOUNDRY DATA SHEET, JUNE, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

FORMULAS FOR THE BRASS FOUNDRYMAN

Strong Aluminum Alloys

The following alloy is used extensively in the manufacture of automobile pistons, aluminum worm wheels, and for all purposes requiring an alloy of more than the usual strength.

First make the following hardener:

Melt together under charcoal

	Pounds.
Copper	10
Nickel	1¼

When thoroughly fluid, add 5 pounds of aluminum in small pieces, and while the alloy is at a high temperature, add 3¾ pounds of tin plate and stir vigorously with a thin iron bar until all the tin plate is dissolved. The alloy should be thoroughly fluid, that is, no lumps should be located by the stirring bar. At this stage, add gradually 10 pounds of aluminum, making a total of 15 pounds of this metal; thoroughly stir the bath and ingot.

To make the aluminum alloy, place a crucible of suitable size in the furnace and melt therein 83½ pounds of aluminum; allow it to attain a very dull red temperature, then add 6 pounds of the hardener, and ½ pound of magnesium; stir well to insure the thorough incorporation of the added metals; follow with an additional 10 pounds of aluminum, making a total of 93½ pounds of this metal, 6 pounds of hardener and ½ pound of magnesium. The resulting alloy then will approximate the following composition by analysis:

	Per Cent.
Aluminum	95.98
Copper	2.00
Nickel	0.24
Iron	1.00
Silicon	0.40
Magnesium	0.38

When carefully made this alloy should possess the following physical properties:

Ultimate strength, pounds per square inch	27,000 to 29,000
Yield point, pounds per square inch	12,000 to 14,000
Elongation in 2 inches, per cent	3.50 to 4.00
Reduction of area, per cent	4.00 to 5.00

The Foundry, Data Sheet No. 235, June, 1917.

FORMULAS FOR THE BRASS FOUNDRYMAN

Aluminum Alloys Suitable for Drawing Into Wire.

Alloy A

	Per Cent.
Aluminum	98.40
Copper	1.60

To make the alloy, melt together 96.80 per cent of pure aluminum and 3.20 per cent of an alloy composed of 50 per cent copper and 50 per cent of aluminum.

Alloy B

	Per Cent.
Aluminum	97.70
Copper	1.00
Nickel	1.30

In making alloy *B*, first make a hardener, as follows:

	Per Cent.
Copper	20.00
Nickel	26.00
Aluminum	54.00

To make the alloy melt the following together:

	Per Cent.
Aluminum	95.00
B hardener	5.00

Alloy C

	Per Cent.
Aluminum	98.00
Manganese	2.00

In making alloy *C*, use the commercial alloy of manganese and aluminum which contains approximately 20 per cent of manganese and the balance aluminum. This is the safest method of making the alloy from the standpoint of the ordinary brassfounder.

Physical Properties

The physical properties of the foregoing alloys will be approximately as follows:

Alloy A

Electrical conductivity, 50 per cent of that of copper. Tensile strength, 39,000 pounds per square inch in wire.

Alloy B

Electrical conductivity, 49 per cent of that of copper. Tensile strength, 45,500 pounds per square inch in wire.

Alloy C

Electrical conductivity, 48 per cent of that of copper. Tensile strength, 35,000 pounds per square inch in wire.

The Foundry, Data Sheet No. 236, June, 1917.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

The Evolution of the Die-Casting Process---I

A Discussion of Early Practice Underlying the Development of the Die Cast Part Which Has Attained a High State of Perfection

By Charles W Pack

FORMING various shapes of metal by means of the die-casting process is the outcome of a long series of developments in metal casting. The die-casting process as an individual industry dates back less than 25 years, but the fundamental principles were known as far back as the fifteenth century.

In tracing the advance in the metal casting art it is found that the methods used, even in the prehistoric ages, are being utilized today, and in studying metal founding of that time, we are obliged to seek information on the subject from the religious teachings laid down in the Bible; or we must investigate the scientific writings of many learned archeologists. The hieroglyphic inscriptions found in caves and dwellings of prehistoric men are the basis of much that has been written regarding the early forms of metal casting.

In the Bible we find many references to the casting of metals. The casting of the golden calf by Aaron is probably the most prominent and best remembered, although reference is also made to the casting of idols used by the Egyptians and other infidel races for worship. Aaron's work is described in the following words: "And all the people broke the golden ear rings which were in their ears and brought them unto Aaron. And he received them at their hands and fashioned it with a graving tool after he had made it molten calf." We also find that King Solomon's throne was adorned by two huge bronze lions and in many other instances there appear references to the casting of metal. The value of Biblical statements in scientific research has been questioned, but there are many facts that point to their probability.

Work of Egyptians

There seems to be little doubt that the ancient Egyptians were well versed in the art of metal casting and were also familiar with the basic metallurgical and chemical principles involved in the reduction of metals from their ores. If Aaron really cast the golden calf he undoubtedly learned the art from the Egyptians. It is unfortunate that no written history has been handed down from that ancient race since it is generally believed that they possessed a vast amount of metallurgical knowledge which was lost before history could record it.

In describing the royal tombs of the first dynasty of Egypt, dating from about 4000 B. C., William Flinders Petrie states "that gold hawks had been cast in a mold and the junction line carefully removed and burnished". This quotation by Petrie is of interest inasmuch as he claims that the Egyptians had been producing metal castings in the year 4000 B. C., which antedates the beginning of the Hebraic calendar by about 300 years and leads to the belief that the golden calf incident is worthy of serious thought.

From a practical standpoint, however, we are more particularly interested in the metals, alloys, fuels, furnaces and molding compositions used rather than the purely historical aspect of the subject.

Fig. 1 is reproduced from a wall painting in an Egyptian tomb and is dated 1500 B. C. From this picture it appears that the Egyptians first alloyed their metals and poured them into ingot molds. The furnaces of the most ancient type consisted merely of a hole dug in the ground to hold the crucible and fuel. In the picture one man is shown fanning the fire with a bamboo matting to create a draft. This picture appears to represent a forging rather than a casting shop. The metal was undoubtedly poured into the ingot molds, heated to the proper temperature and forged out to the various shapes. The figures in the upper part of the picture appear to be showing some of the forged implements.

Fig. 2 is also taken from an Egyptian wall painting and shows a more advanced method of creating a draft for the fire. Here the foot bellows seem to have been in use. This bellows was operated by two men alternately raising and lowering their feet. In the upper part of the picture one man appears to be stirring

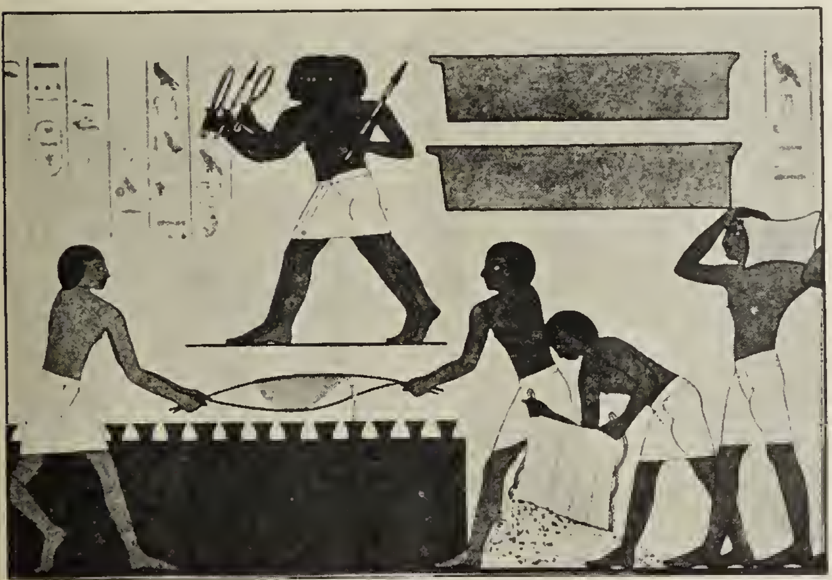


FIG. 1—EGYPTIANS CASTING METAL 1,500 B. C.

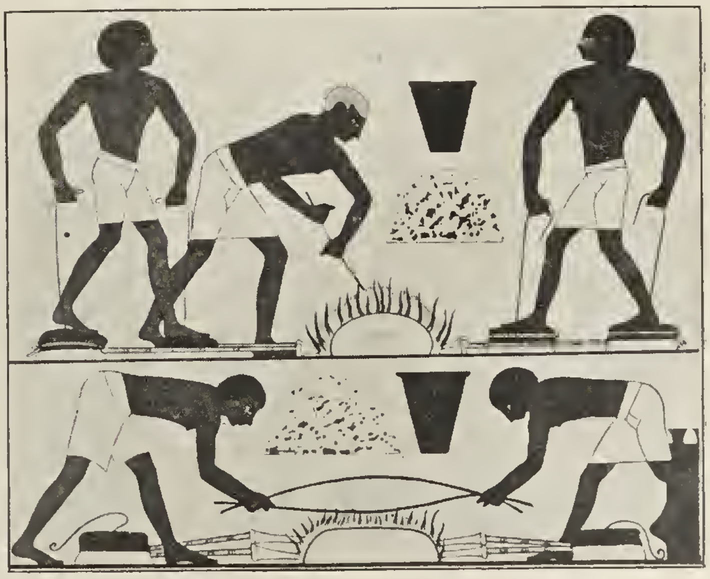


FIG. 2—EGYPTIAN FURNACE 1,500 B. C., SHOWING BELLOWS

Presented at the Cleveland meeting of the Institute of Metals, September, 1916. The author, Charles W. Pack, is with the Doehler Die Casting Co., Brooklyn, N. Y.

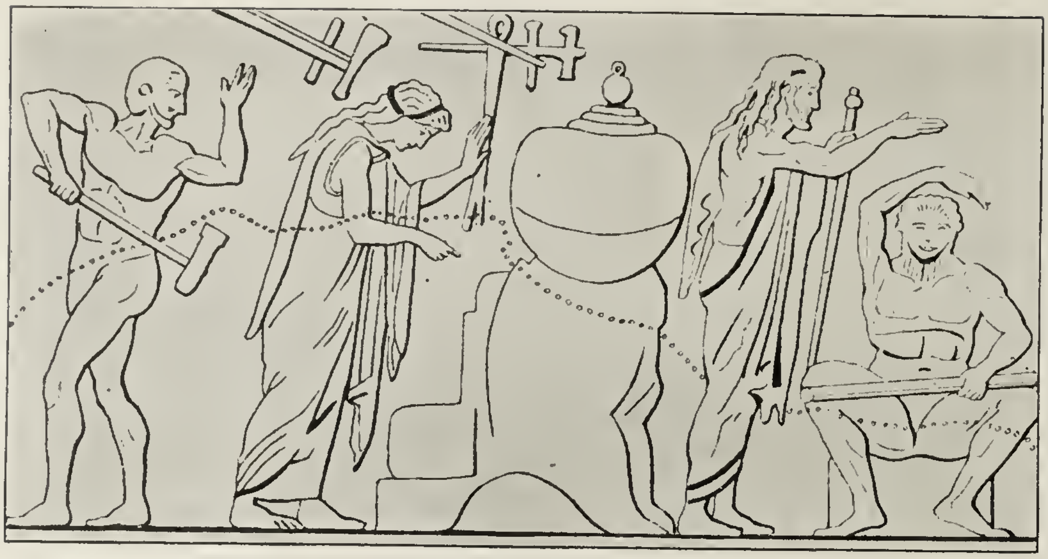


FIG. 3—DRAWING OF A GREEK FURNACE REPRODUCED FROM A VASE

the metal while in the lower part the men appear to be preheating the crucible preparatory to pouring.

Although the Egyptians practiced the art of metal casting long before any other nation, the Greeks were undoubtedly the most skillful in this art during the 10 centuries immediately preceding the beginning of the Christian era. One of the seven wonders of the world is the bronze statue of the sun god Helois, in Rhodes, commonly known as the Colossus of Rhodes. made by a Greek named Chares, during the reign of Demetrices in the fourth century before Christ. This work occupied him for 12 years and when finished stood 105 feet high, weighing 360 tons. The statue was destroyed by an earthquake in 224 B. C. The remains lay scattered for about 1,000 years and were then sold to an enterprising junk dealer who resold the bronze for the manufacture of war material. Other Greek colossi such as the Apollo of Calamis, the Zeus and Hercules of Lysippus and the Zeus at Olympia are among the most remarkable castings of any age. In 479 B. C. a bronze pillar was set up by the Greeks to commemorate their victories. It was about 20 feet high cast in one piece, hollow with the frame of the states engraved on it.

Greek Statue-Makers

Fig. 3 is reproduced from an ancient Greek vase and is believed to represent a statue-maker's shop, dated about 500 B. C. The furnace shown here is of a more advanced type than that used by the Egyptians, it being raised and allowance being made for draft at the bottom. A statue in the process of assembly is shown at the right of the picture and a number of the tools used are also in evidence.

Fig. 8, also taken from a vase of the same period, gives a better view of the furnace used and shows that they also used the fire box for annealing their ingot metals preparatory to hammering. The mallet, hammer and tongs are the same as those used at present.

A whole series of molds belonging to the twelfth dynasty of Egypt (about 2400 B. C.) has been unearthed. The molds were carved in thick pieces of clay, baked into pottery and lined with a fine ashy clay. In the lake dwellings of Switzerland have been found various molds of rock and clay which date from 1000 to 2000 B. C. Rock seemed to be preferred for the flat objects and clay was used for the more complicated molds. Whether the first molds were of stone or baked clay is uncertain since stone and clay were more closely related to the pottery art which is far older than recorded history.

Rock and Clay Molds

Both rock and clay molds, or at least some of them, were constructed in halves or even more parts so that they could be preserved. Holes for plugs are to be seen which were used in fitting the parts of the molds together. Molds found in Troy likewise show the use of both stone and baked clay, some of them being constructed in symmetrical halves.

The stone molds shown in Fig. 6 were undoubtedly constructed in symmetrical halves and were used in casting swords at Troy. Fig. 5 shows terra cotta molds dated 1600 B. C. These molds probably were used for casting some offensive or defensive weapon of that age. Fig. 4 shows a number of stone and baked clay open and closed molds taken from the lake dwellings of Switzerland and dated 1000 to 1500 B. C.; *A* and *B* are sec-

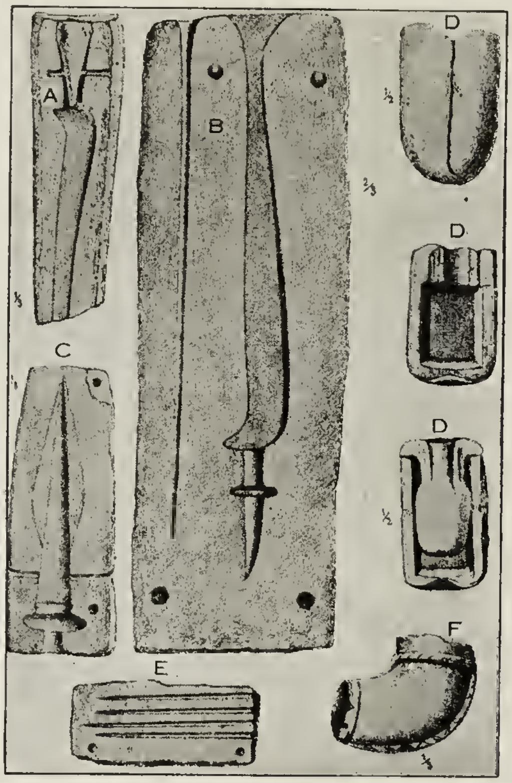


FIG. 4—STONE AND BAKED CLAY MOLDS

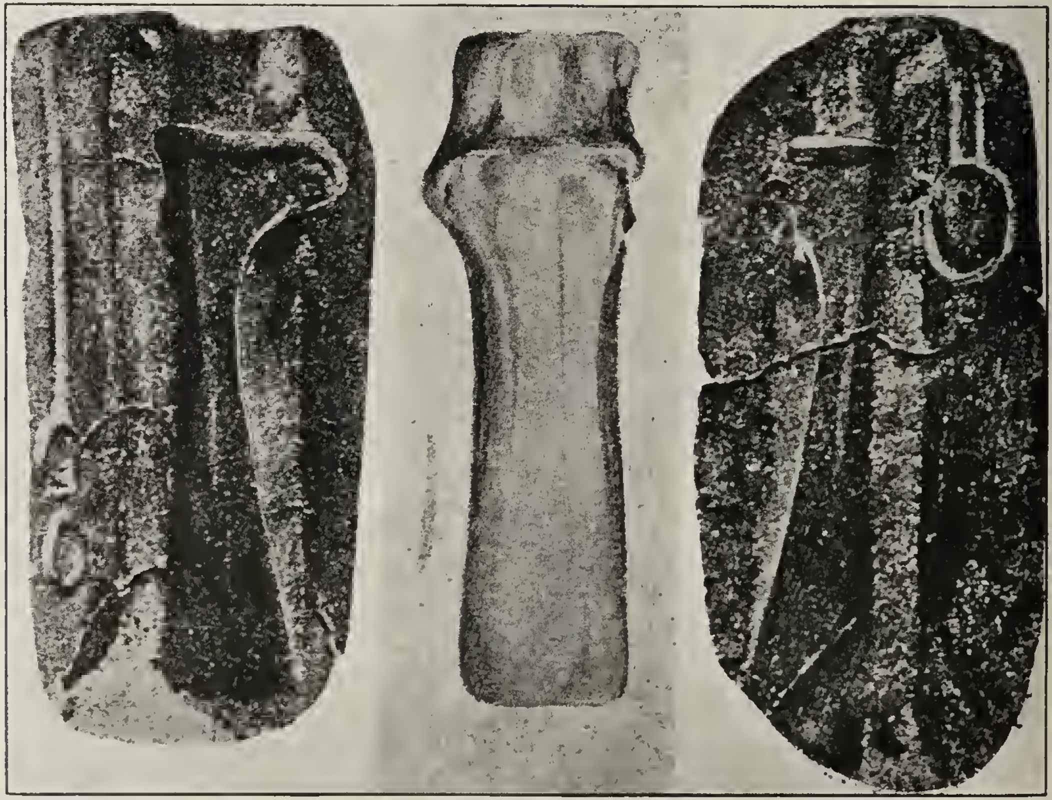


FIG. 5—TERRA COTTA MOLDS, 1,600 B. C.

tional views of sword molds, the latter showing dowel pins used for locating the two halves; *C* represents a mold used for casting spear heads, *D* shows a mold for casting hammer heads, and *E* is a mold for casting pins; *F* shows a closed mold for casting a curved part.

Before leaving the subject of ancient casting processes, the part played by Japan in developing the art of casting metal should be mentioned. Very little is known of the casting art as practiced in Japan because much Japanese history has been kept sealed from the civilized world by traditions which have only been laid aside during the past 50 years.

Fig. 7, copied from a print preserved in the Smithsonian Institute, represents the shipping department of a wire rolling, or more properly, a wire hammering shop. This shows the coils of wire, with an employe carrying a bundle evidently made from wire. Other parts of this print, not illustrated here, show the casting room which bears a remarkable resemblance to the equipment employed in modern brass casting plants. Other portions of this print also clearly outline the method of pouring the metal into small ingots which undoubtedly were hammered into wire. The operation of cutting the metal into strips also was performed by the Japanese.

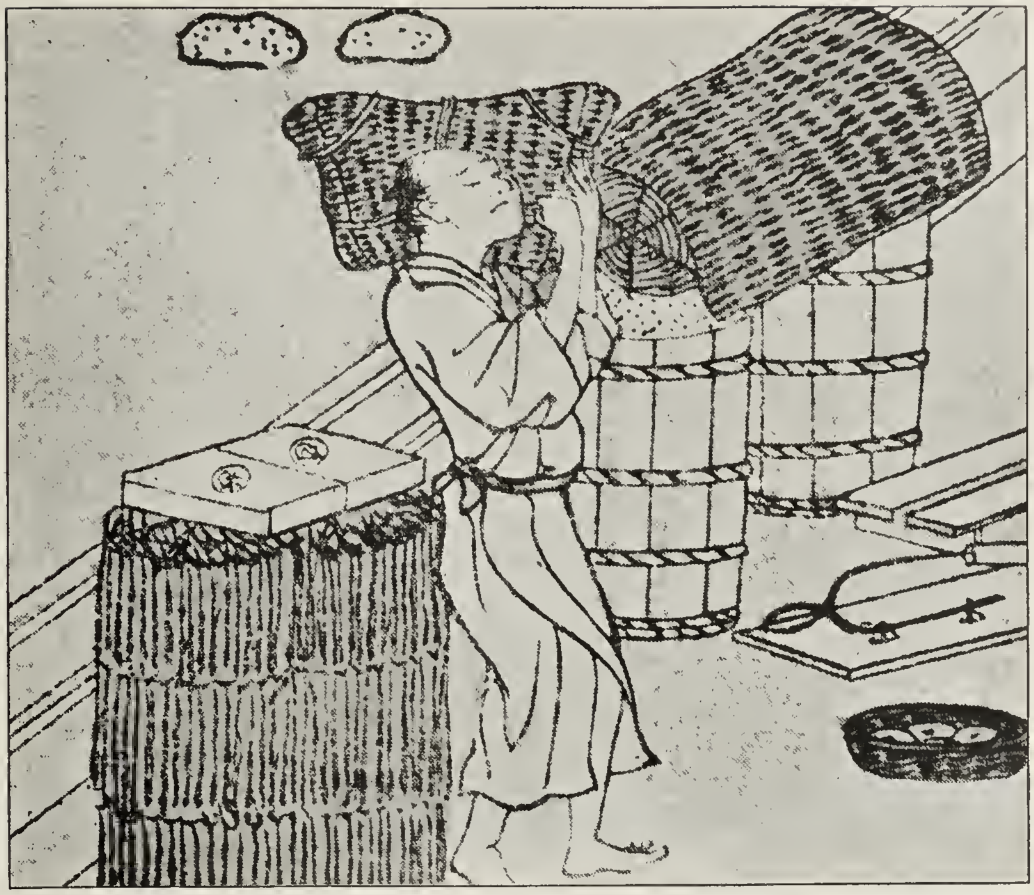


FIG. 7—MEDIEVAL JAPANESE PRINT FROM THE SMITHSONIAN INSTITUTE

Metals and Alloys

The next subject with which we are concerned is that of the metals or alloys used in the prehistoric arts. Here again we must depend upon quotations of writers and upon the analyses of the few samples unearthed.

Science divides the human progress during the prehistoric ages into three groups—the stone age, the bronze age and the iron age. These ages cannot be distinctly attributed to any definite century or centuries since they varied in different parts of the earth in accordance to the degree of civilization. The end of the stone age and beginning of the bronze age is generally placed by various writers to be between 2000 and 3000 B. C.

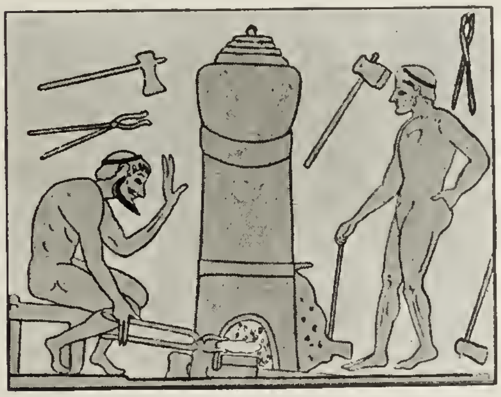


FIG. 8—ANCIENT GREEK FURNACE FROM A VASE

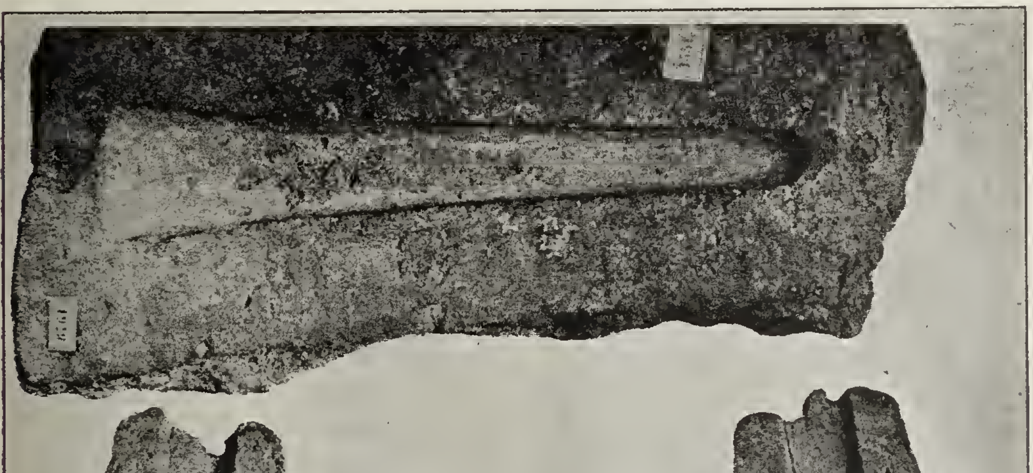


FIG. 6—STONE MOLDS FOUND AT TROY

Priority of Brass and Bronze

Although there is considerable discussion as to the priority of the iron and bronze ages, the writer believes that iron must have come before bronze, because it must have been discovered very early in the form of meteorites. It is also believed that copper was used before bronze since the former is found in nature ready for the hammer, whereas for the production of the bronze a reduction or alloying process is necessary. King, in his history of Sumer and Akkad, says of the Sumerians: "The art of casting in metal was also practiced by the Sumerians and even in the earliest period anterior to the reign of Ur-Nina (about 3000 B. C.) small foundation figures have been discovered which were cast in solid copper."

An analysis of the metal of such remnants shows that it was copper and not bronze, indicating that the latter alloy had not come into use in that district.

The question that next arises is the priority of brass or bronze in history To arrive at any satisfactory conclusion to this problem, we must ask ourselves "What is brass and what is bronze?" The British Institute of Metals appointed a committee in April, 1912, to define brass and bronze. This committee reported that brass was a

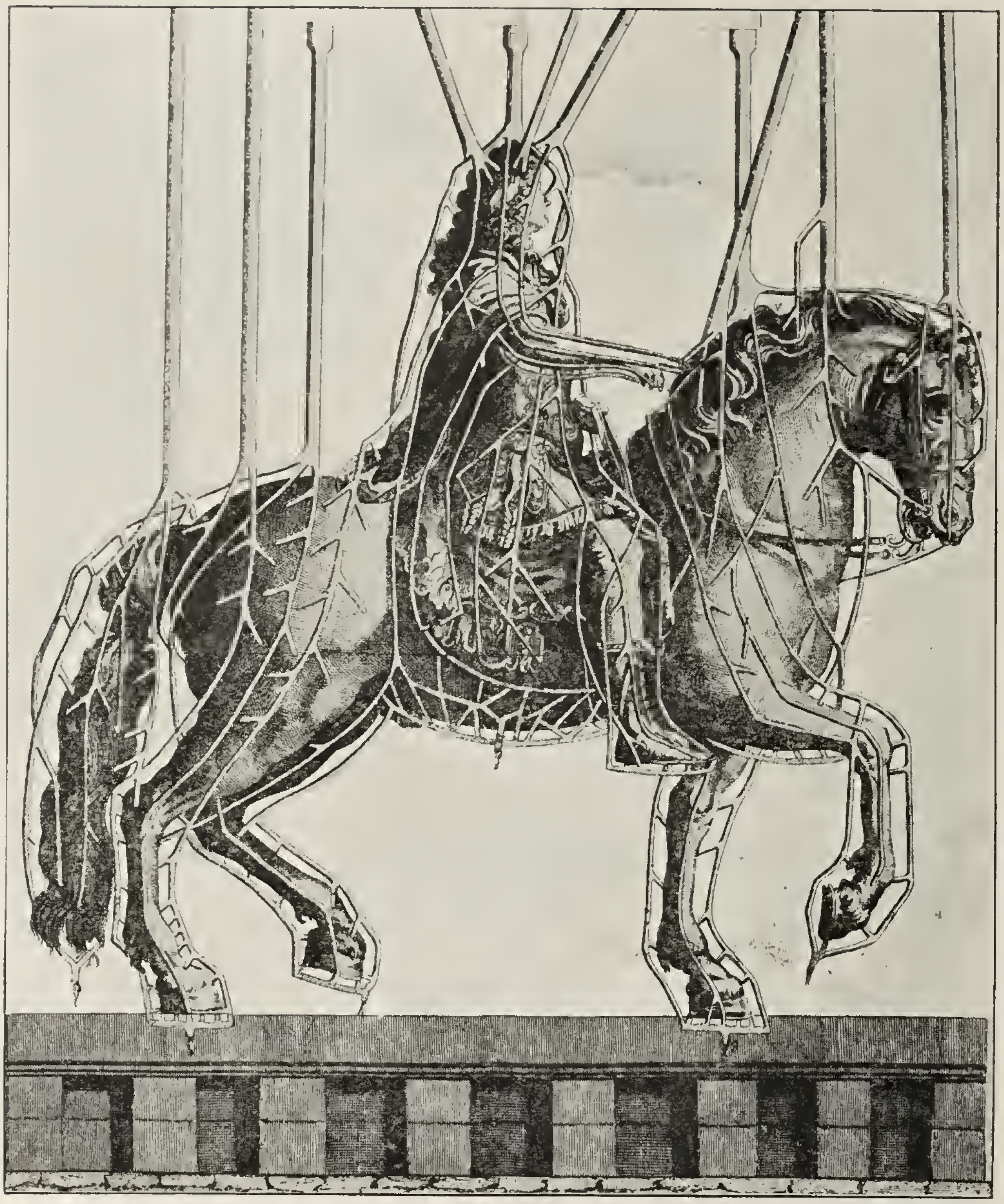


FIG. 9—CIRE PERDUE PROCESS, WAX FIGURE OF LOUIS XIV (1699)

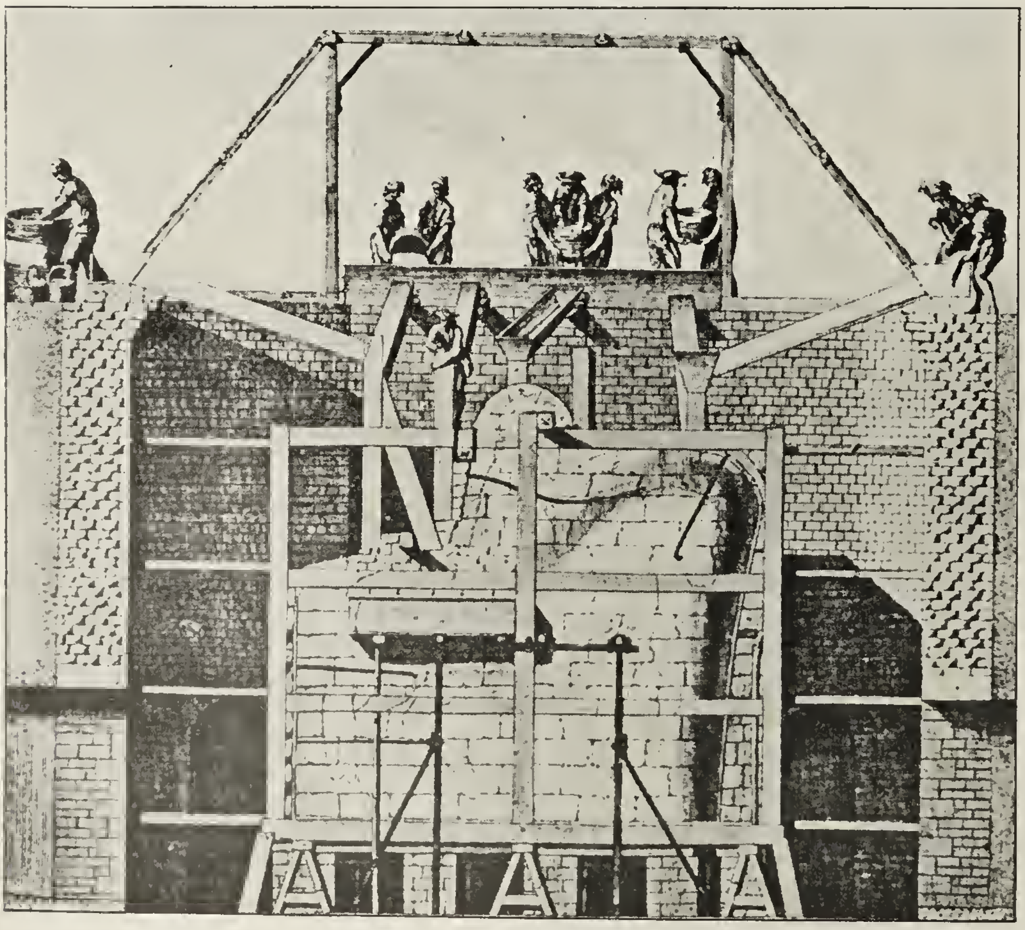


FIG. 10—SHOWING METHOD OF POURING EMPLOYED IN THE LOST WAX PROCESS

copper-zinc alloy having a copper content of over 50 per cent, whereas bronze was a copper-tin alloy also having a copper content of over 50 per cent. Nevertheless there are so-called bronzes on the market that contain no trace of tin, and others that contain as high as 40 per cent zinc. Assuming the definition laid down by the Institute of Metals, we are led to the belief that the bronzes or copper-tin alloys were cast long before the brasses or copper-zinc alloys. The Phoenecians brought tin from Cornwall in 1100 B. C., or before the building of King Solomon's temple. Hiram is said to have made articles of brass for the temple (1004 B. C.), but there is a dispute as to the terms of brass and bronze. Some editors of the Bible use the term brass and others the term bronze. Hiram procured his tin from Cornwall and his product was undoubtedly a bronze. The bronze was poured into molds and it is believed that the implements were tempered or hardened as desired. The ancient European bronzes which have thus far been analyzed show no traces of zinc, but contain tin in varying proportions, a few also showing lead and some lead and iron. The Chinese state that Yu, who was a semi-king with a partner Chun on the throne of China, 2200 B. C., caused nine vases to be cast of bronze on which were engraved maps of the nine provinces of the empire.

Use of Brass

Brass was known to the ancients as a more valuable kind of copper. The "Brazen Bull" was cast by Perillus, of Athens, 570 B. C. This was a statue made hollow to receive victims to be roasted to death. It is peculiar to note that the artist was the first victim and the king who condemned him was forced to try the experiment himself later. Brass was known during the classic Greek period as "orchalcum", or mountain bronze.

In the foregoing I have endeavored to give an outline of the status of the metal casting art up to and including the beginning of the Christian era. There began at this period a series of endless religious wars. Political conspiracies to satisfy personal ambition, coupled with sham religious doctrines, caused the wreck of the Roman empire, and turned the civilized parts of Europe, Asia and Africa into a seething caldron of religious fanatics whose only aim was to conquer and exterminate the conquered. Conditions during the tenth century became so bad and the outlook was so dark that the belief became prevalent that the world would come to an end during the year 1000. At this time all interest in life seemed to have been lost by the people. Buildings and artistic structures were allowed to go to ruin. It is surprising that under such conditions metal casting as well as the other arts should have deteriorated. Little or no progress seems to have been made up to the fifteenth century, and it is doubtful if the men living in this age were as well versed in the art of casting metals as the ancients. One of the few records concerning the art of metal casting during the dark or middle ages is given by Theophilus in his "Schedule of the Various Arts". His description of the casting of a silver vase follows:

"Take two pieces of iron, equal in length and width, the measure of a palm and the thickness of a straw, evenly beaten and without a flaw, and carefully smoothed with a plane. Make between these an iron binding, beaten smoothly and moderately thick, which you will bend in the fashion of a circle, of such a size as can apparently be filled with the silver you wish to cast in it. When you have bent it do not join the ends together, but separate them a little, giving an opening through which you can pour in the metal. Fit this circle equally between the iron plates with the ends a little beyond the irons and bind these with three strong iron hooks, below and on each side near the opening. Then plaster beaten clay around the circle between the irons and abundantly near the opening. When this mold has become dry, warm it and pour in the melted silver."

Introduction of Printing

With the introduction of printing by Gutenberg in 1454 the awakening began. Knowledge spread more rapidly than heretofore, and the result was that the spirit of progress so long dead sprang to life once more and led to various discoveries in the arts and sciences.

The discovery of the Cape of Good Hope, and later the discovery of America by Columbus during the fifteenth century, were sure signs that the march of progress had actually begun.

Metal casting progress after the fifteenth century may be attributed to the manufacture of art work, fire arms, industrial appliances and the development of printing.

The casting of fine statuary work, although an important industry today, does not receive as much attention as it did during the classic Greek period or even during the five centuries immediately succeeding the dark ages. It is doubtful if anyone could be found in this age of commercialism who would spend 12 years on a

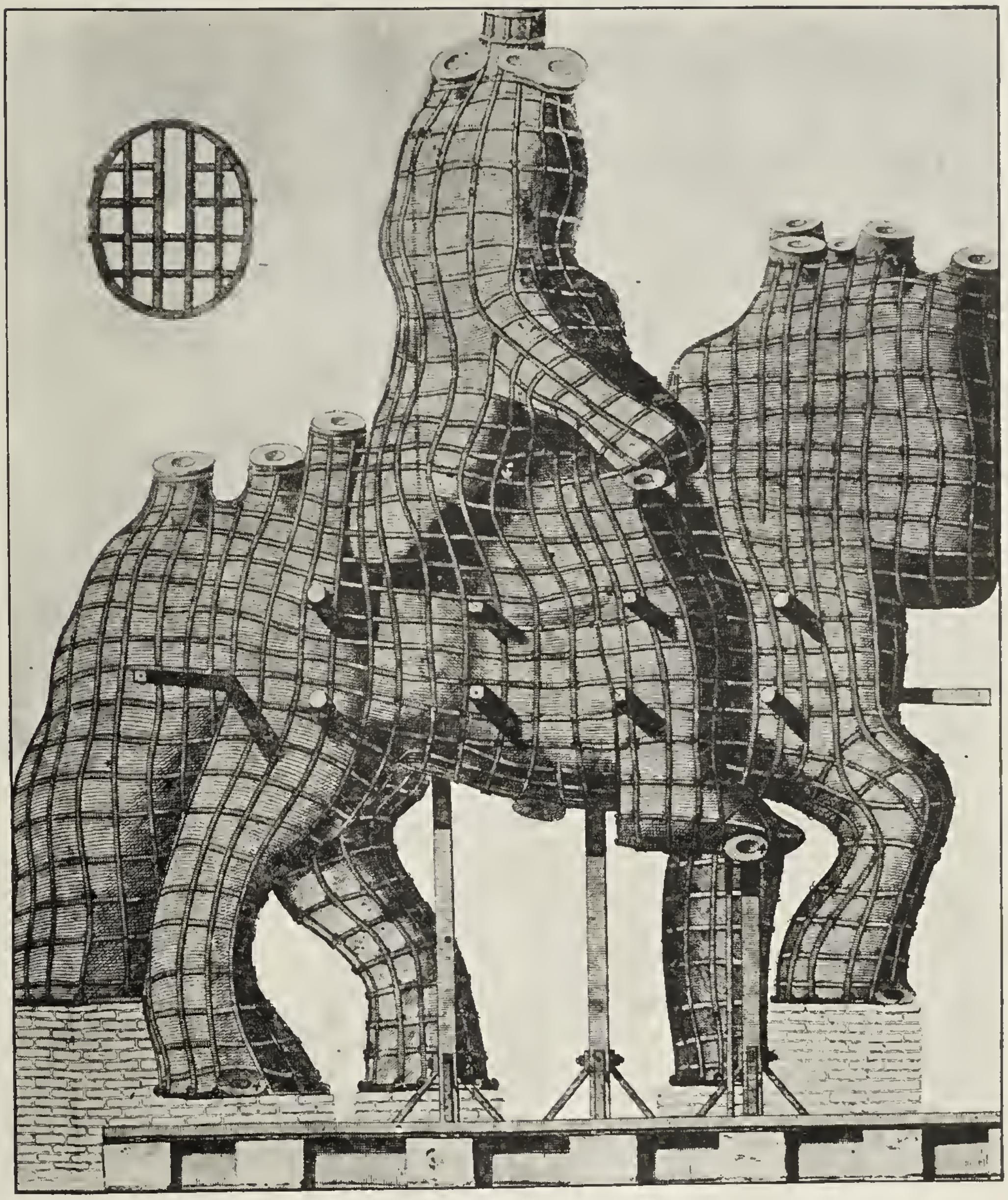


FIG. 11—CIRE PERDUE PROCESS, FIGURES COVERED WITH CLAY

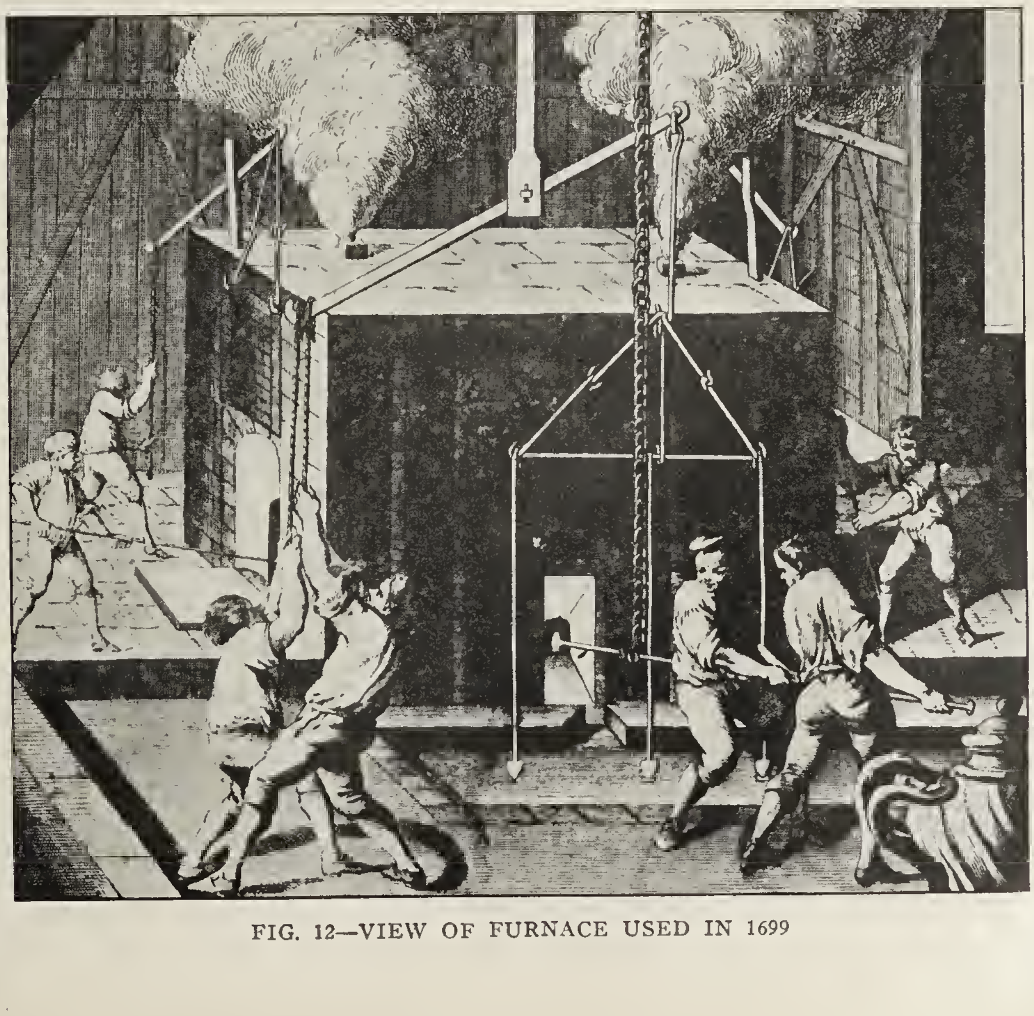


FIG. 12—VIEW OF FURNACE USED IN 1699

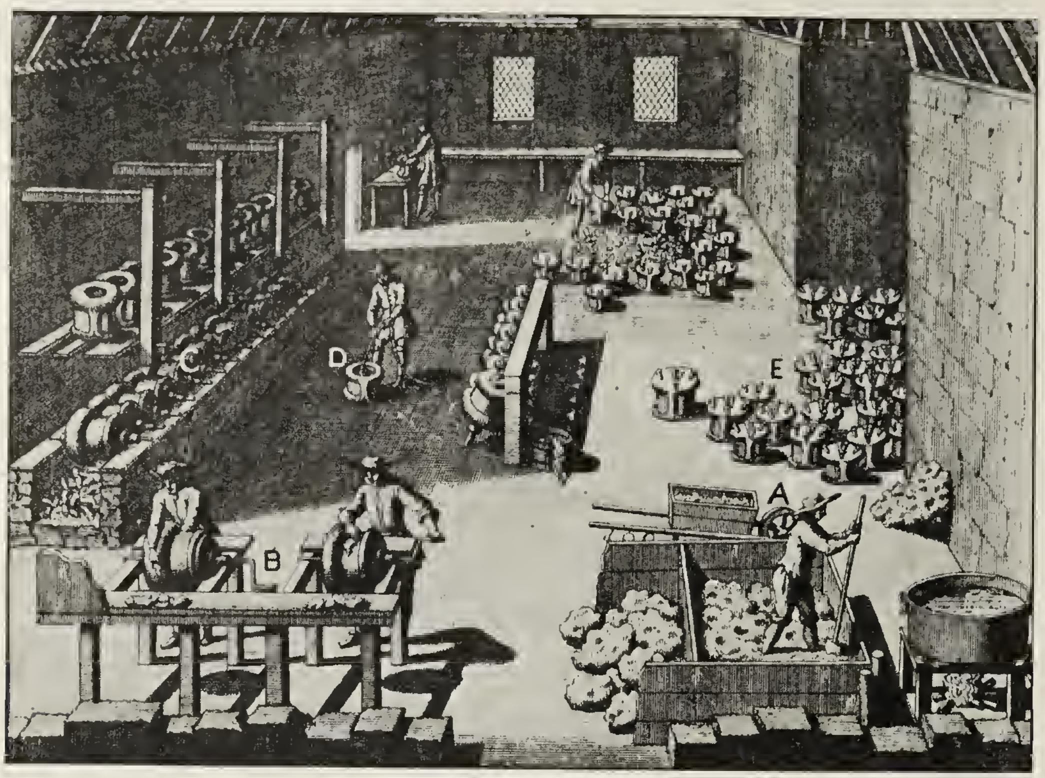


FIG. 13—PREPARATION FOR CASTING IN CLAY, 1718

single piece of work, as did Chares on his Colossus of Rhodes. The amazing amount of patience and labor put into the bronze statuary castings by the latter-day artists is vividly described by Cellini, one of the foremost artists of the sixteenth century, in his treatises, extracts of which will be given later.

The Lost Wax Process

The process used by Cellini was what is known as the *Cire Perdue,* or "Lost Wax Process". This process used extensively at the present time, in its simplest form consists in making a model of wax, surrounding it with suitable molding composition, baking to remove the wax and replacing the wax with metal, usually bronze.

Fig. 9, a reproduction of a picture dated 1699, shows the wax outline of an equestrian statue of Louis XIV. Cellini describes this step in the process very clearly as follows:

"I made a model in clay of just the size the figure was to be. This done, I estimated that the shrinkage would be about one finger thickness, so I very carefully went over the whole, touching it up and measuring it as the art directs. Then I gave it a good baking and after that I spread over the whole an even coat of wax of less than a finger thickness, similarly adding wax where I thought it needed it or even taking a little from off the waxen coat that was over the whole. This method I pursued with infinite diligence and care."

This photograph shows the attention given to gating and venting of the figure. All precautions were taken to insure the proper removal of the wax and volatile gases as well as the filling-in of the metal in every detail. The next step in the process was to coat the mass with clay or other material capable of withstanding the action of the molten bronze. The entire mass was then reinforced, banded with iron bands and otherwise supported to withstand the strain while the metal was being so poured. Fig. 10 shows the appearance of the mold ready for baking and subsequent pouring.

Mixing the Clay

The mixing and application of the clay used for the mold is also described by Cellini in his egotistic though inimitable way, as follows:

"I pounded up some ox bone, or rather the burnt core of ox horns. It is like a sponge, ignites easily and is the best bone you can get anywhere. With this I heat up half a quart of gesso of Tripoli and a quarter of a pint of iron filings and mixed the three well together with a moist solution of the dung of horses or kine which I first passed through a sieve of fresh water until the water took the color of the dung. The whole formed a composition which I applied to my model with hog sables, arranging the bristles so that their softer and outer ends formed the ends of the sables and were thus tender to work with. Thus I gave the whole figure an equal coating of the composition all over. Then I let it dry and similarly gave it two more coats each time letting them dry. These coats were about the thickness of the back of an ordinary table knife. This done, I gave it a coat of clay about half a finger thick, let that dry too, and finally a third coat of the same thickness."

Here Cellini digresses to explain about the clay. He says that the clay should have a certain sandiness. He further states that you should prepare it long before by sifting it carefully, mixing it with cloth frayings and with water to the thickness of a dough, beating it up and letting it decompose for at least four months.

The next step in the process was to lower the mold into a pit baking with a small fire so as to melt out the wax, care being taken to prevent it from boiling. The fire was then raised to drive off all moisture. It was then encased in bricks and clay and fired well until all organic mat-

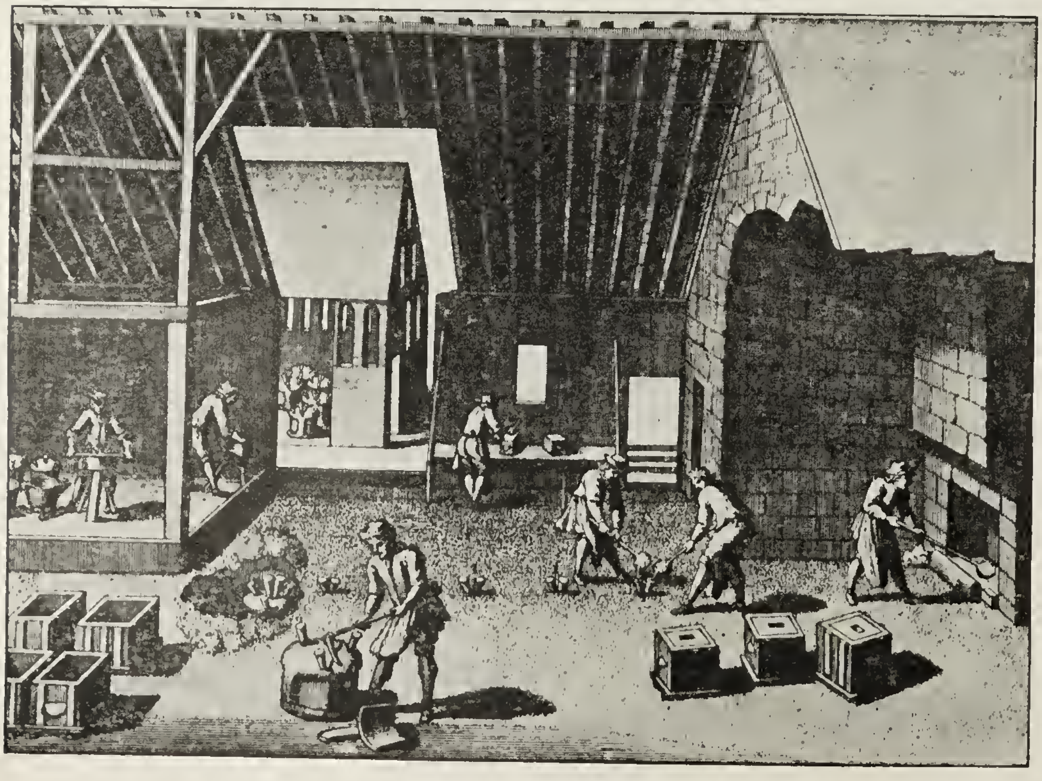


FIG. 14—INTERIOR VIEW OF FOUNDRY 1718

ter was entirely carbonized. The mold was then securely packed with soft earth and sand and poured through troughs from a furnace at a higher level. Fig. 10 shows the mold in position for pouring. The outline of the figure can be seen faintly by the dotted line. The men are shown constructing the clay-lined pouring troughs which lead the metal into the proper grates. A view of the furnace and melting room is shown in Fig. 12. The furnace is of the reverberatory type, the metal being tapped from the bottom and is allowed to run into the troughs below as shown in the previous illustration.

In the casting of his famous bronze Perseus, Cellini states that he was taken sick and the workmen let the bronze cake, but Cellini saved it by throwing oak wood on the fire. This melted out the tin, but Cellini again arose to the occasion by throwing in his pewter dishes. In describing the making of Cardinal's seals, Cellini mentions that occasionally a volcanic sand was used for molding.

Loam Method

The clay or loam method of casting was in use from time immemorial and was preferred for some purposes even after the invention of sand molds. It was particularly well adapted to the casting of peculiarly shaped kettles and bells.

Fig. 13 illustrates the clay and loam process as applied to the casting of kettles. The core for a kettle was made by wrapping hemp rope on a spindle to the approximate contour of the interior of the kettle. Clay was then applied to the rope core and the spindle revolved on the table until the rope was well covered and the outside took the shape of a templet made to conform to the shape of the core. The core was then well smeared with grease and covered with another layer of clay and revolved until the outside took the shape of a templet which was made to conform to the outside of the pot to be cast. In this manner a false kettle in clay was produced on the clay core. The whole was then again well greased, more clay applied and again revolved until the entire mass took the shape of another templet made to conform to the outside of the mold. In this manner three distinct layers of clay, each separated by a film of grease, were produced on the rope.. The entire mass was well baked, and with a knife the two outer layers were cut through the center line. The false clay casting was destroyed, the outer mold, now in two halves was replaced, leaving a space conforming to the shape of the casting desired. To prevent the core and outer mold from touching, lead balls whose diameter conformed to the thickness of the casting, were placed between the core and outer mold. Molds for legs and handles were made separately and were attached to the mold, as were also gate channels. After baking, the molds were embedded in the ground surrounded by soft sand.

In Fig. 13, *A* shows the man kneading and suddling the loam or clay with the feet, and also illustrates the wheelbarrow, heated water, etc.; *B* shows one man applying a layer of loam or clay with the templet and sizing the mold. The second workman is measuring the position for the handles. At *C*, the finished molds are shown baking over a long open furnace. The rope core is being withdrawn at *D*, and at *E*, the baked molds ready for pouring are shown. In Fig. 14 the pouring floor is illustrated.

The finished clay molds are embedded in the ground, only the gate holes protruding above. Two men are seen pouring, this particular casting requiring two gates which were poured at the same time.

One man is shown ladeling the metal from the furnace which appears to be of the pit type. The two men at the left, as well as the men in the foreground, are engaged in freeing the casting from the mold. For this purpose the mold is set upon a stool. Sand molding which had just come into practice is also shown in this view, one molder being at work in the background and a number of the flasks in evidence in the foreground.

Helmet for Arc Welders

A helmet for arc welders is illustrated and described in a 4-page folder issued by the Julius King Optical Co., New York City. This helmet affords protection to the eyes and faces of workmen from intense heat and light and yet permits the free use of both hands. It is constructed of black fibre which is a non-conductor of electricity and weighs only 23 ounces complete with the lenses. The cap furnished with the helmet is chemically-treated and fireproof, and is fitted with a self-adjusting spring head band.

David McLain, Goldsmith building, Milwaukee, is installing an open-hearth furnace in the plant of the George H. Smith Steel Casting Co., Milwaukee, which will have an output of from one to two tons per heat. The first heat in the furnace which Mr. McLain installed at the plant of the Lenoir Car Works, Lenoir City, Tenn., recently was made.

Testing Engineers Outline Comprehensive Program

A comprehensive program of papers and committee reports, requiring 10 sessions for presentation and discussion, has been outlined for the twentieth annual meeting of the American Society for Testing Materials to be held at the Hotel Traymore, Atlantic City, June 26 to 29. The opening session, Tuesday morning, will be devoted to the consideration of committee reports on "Wrought Iron", by S. V. Hunnings, chairman; "Revision of Pipe Threads", by H. V. Wille, chairman; "Magnification Scales for Micrographs", by W. H. Bassett, chairman, and "Standing Committees", and "Papers and Publications", by Edgar Marburg, chairman.

Papers and committee reports on tests and testing will be considered Tuesday afternoon. "Methods of Testing" will be the subject of a committee report, by G. Lanza, chairman. Among the papers to be read at this session are the following:

"Endurance and Impact Tests of Metals," by D. J. McAdams Jr.

"Rapid Semi-Autographic Tests for Determining the Proportional Limit," by H. F. Moore.

"The Use of the Scleroscope for Measuring the Elasticity of Non-Metallic Materials," by A. F. Shore.

On Tuesday evening, A. A. Stevenson, president will deliver his annual address and a reception will be tendered to the members and guests. Wednesday morning, June 27, will be devoted to the discussion of committee reports and papers on steel and iron, as follows:

Report of the Committee on Steel, by C. D. Young, chairman.

Report of the Committee on Cast Iron, by Richard Moldenke, chairman.

Report of the Committee on Corrosion of Iron and Steel, by S. S. Vorhees, chairman.

Report of the Committee on Magnetic Properties of Iron and Steel, by C. W. Burrows, chairman.

The following papers also will be presented:

"Some Applications of Magnetic Analysis to the Study of Steel Products," by C. W. Burrows.

"Annealing Temperatures and Grain Growth," by D. J. McAdams Jr.

The role of the several alloying elements in steel will be the subject of a topical discussion to be opened by H. M. Howe and other speakers will be announced later.

Non-ferrous metals will be considered Wednesday evening, the session to be opened by a report of the committee on non-ferrous metals and alloys, by William Campbell, chairman. The following papers will be read:

"Testing of Sheet Brass," by C. H. Davis.

"Specifications and Inspection for Brass and Bronze," by A. D. Flinn and Ernst Jonson.

"Interior Surface Defects on Brass Condenser Tubes as a Cause of Corrosion," by W. Reuben Webster.

"Effect of Light vs. Heavy Reduction in Cold-working Brass," by W. Reuben Webster.

"The Hardness of Hard Drawn Copper Wire," by Edwin H. Peirce.

"The Electrolytic Determination of Tin on Tinned Copper Wire," by G. G. Grower.

Thursday morning will be devoted to the consideration of preservative coatings and miscellaneous materials and the report of the committee on preservative coatings for structural materials will be presented by P. H. Walker, chairman. Thursday evening, cement and concrete will be considered; Friday morning, June 29, concrete and lime, and on Friday afternoon, ceramics. The tenth and closing session on Friday evening will be devoted to the consideration of the various committee reports on miscellaneous materials.

Officers for the ensuing year have been nominated as follows: For president, W. H. Bixby, brigadier-general, United States army, Washington, D. C.; for vice president, Edward Orton Jr., dean of the College of Engineering of Ohio State University and state geologist of Ohio, Columbus, O. For members of the executive committee: J. A. Capp, chief of the testing laboratory, General Electric Co., Schenectady, N. Y.; W. F. M. Goss, dean of the Schools of Engineering, University of Illinois, Urbana, Ill.; William M. Kinney, inspecting engineer, Universal Portland Cement Co., Chicago, and C. D. Young, engineer of tests, Pennsylvania railroad, Altoona, Pa.

On April 20 the membership of the society totaled 2,108 which represented a net increase of 37 since the last meeting and compares with a gain of 121 for the previous corresponding period.

A change in the regulations governing standing committees has been authorized by the executive committee, which provides that, as a general policy, only one individual connected with a given firm shall be eligible to membership on a committee, although exceptions to this rule may be permitted at the discretion of the committee concerned. However, if two or more members are connected with the same company, when a division is demanded, they shall jointly command only a single vote.

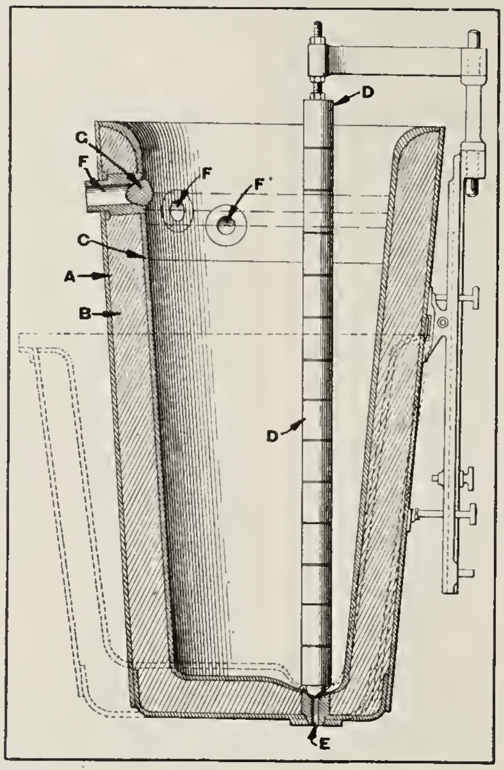
The Stow Mfg. Co., Binghamton, N. Y., has issued miniature reproductions of its catalogs devoted to electric tools and flexible shaft. These booklets are vest pocket size, 3¼ x 4¾ inches.

The Anson-Byrne Co., Chicago, sales agent for the Blaisdell air compressor, Kingsford centrifugal pump and other mechanical equipment, has removed into larger quarters at 10 South La Salle street.

A Self-Skimming Ladle for Pouring Steel for Castings

A new type of ladle for handling molten steel in foundries, the invention of James C. Davis, fourth vice president of the American Steel Foundries, Chicago, and the patent for which was assigned to this company, is shown in the accompanying illustration. This ladle is of smaller diameter and is much deeper than the type of ladle usually employed. It is pierced in the top with several circular openings which are staggered at different levels. The purpose of these openings is to provide outlets for the removal of slag.

The inventor states that the regenerative open-hearth furnace is the most universally employed medium for the production of basic steel. The proper adjustment of the metalloids of this furnace under skilled manipulation is comparatively simple, but when the contents of the furnace have been discharged into the ladle, the opportunity for further practical manipulation and treatment of the slag condition ceases. In its place a reaction commences between the slag and the steel. The tendency of this reaction is to nullify all of the work of purification that is carried out in the steel while in the furnace. In this reaction between the steel and the slag in the ladle, the time element is an important factor and the longer the two are in contact the greater is the opportunity for the reabsorption of metalloids.



NEW TYPE OF LADLE FOR POURING CAST STEEL

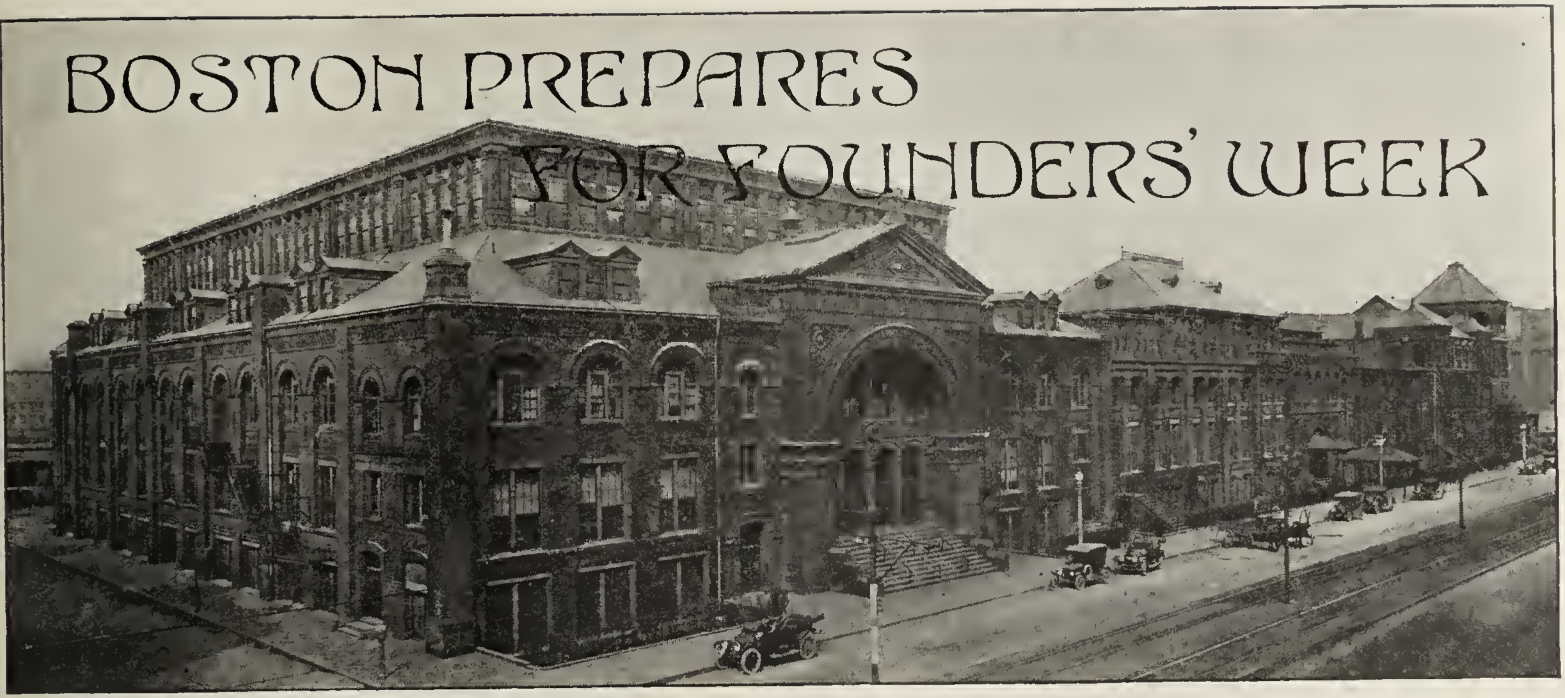
During the time that the steel is in the ladle the combination of calcium with the silicon in the steel occurs, with a resulting interchange of phosphorus which re-enters the steel in the ladle. The effect of the loss of silicon from the steel to the slag is to liberate oxygen, thereby causing the steel to be porous when cast. Through the return of phosphorus from the slag to the steel, the latter is rendered brittle and is unfit for use, if in its ultimate form it is to be subjected to severe shocks or strain.

It is almost impossible to produce an exact quantity of steel of desirable chemical composition in the open-hearth furnace at one time, owing to the various delays which make necessary the addition of more metal than was contemplated in the original furnace charge. It is obviously necessary, therefore, that the ladle into which the steel and slag are to be discharged from the furnace must be of such ample proportions as to properly receive and contain not only the original charge, but such additional amounts of metal which may be found necessary to produce. Therefore, when a heat of steel of normal proportions shall have been discharged into the ladle there is so much space between the top of the steel and the top of the ladle that the ladle receives an excessive amount of slag. This slag remains on the metal until it has been completely discharged from the ladle. It is evident, therefore, that the greater the volume of slag contained in the ladle the greater is the hydrostatic head or pressure exerted by the slag, thereby causing the latter to settle more deeply into the steel and increasing the contaminating effect of the slag.

The new type of ladle makes it possible to expose 45 per cent less area of steel to the detrimental action of the slag than the old style ladle, and has the further advantage of imparting a greater hydrostatic head to the metal which the inventor claims to have the effect of causing the lighter slag to rise to the top of the steel and remain there while the ladle is being emptied.

Before the ladle is filled with steel, the slag openings are closed with a plug composed mainly of silica sand, with a binder of fire clay, and these plugs can be removed as required in order to regulate the height of the slag in the ladle to a proportion just sufficient to serve as a blanket to prevent chilling the steel. As shown in the accompanying illustration, the ladle consists of an exterior shell, *A*, a brick lining, *B*, and a thinner lining, *C*, of material containing magnesite and dolomite. The stopper is shown at *D*, the pouring opening at *E*, and the slag holes at *F*. How the slag holes are plugged is illustrated at *G*.

BOSTON PREPARES FOR FOUNDERS' WEEK



Conventions and Exhibitions in New England

NEW ENGLAND foundrymen already are making extensive preparations for the reception and entertainment of the members of the American Foundrymen's Association and the American Institute of Metals, who will meet in annual convention in Boston, during the week of Sept. 24. Concurrent with this great gathering of foundrymen will be held the yearly exhibition of foundry equipment and supplies, machine tools and accessories, in Mechanic's building, which affords 80,000 square feet of floor space.

Never before in the history of these organizations has as much interest been manifested in this event, as far in advance of the opening date, as this year. Space reservations for exhibits already have been made by 83 manufacturers and last year's total of 150 at Cleveland, promises to be greatly exceeded. The average space per exhibitor also shows a big increase over previous years and the indications are that Mechanic's building will be crowded to capacity. A prominent feature of the Boston show will be the extensive display of machine tools. New England builders promise to be unusually well represented and numerous reservations also have been made by machine tool builders in the central west.

Great Patriotic Demonstration

The Boston exhibition will be a great patriotic demonstration of the preparedness of equipment builders to meet the most exacting needs of foundrymen and machine shop operators in this great crisis. The labor-saving tools that will be displayed will demonstrate how operations can be speeded-up to meet the demands of the government and, in addition, engineers will be in attendance who will explain the intricacies of munitions manufacture.

The program for the technical sessions of the American Foundrymen's Association is unusually complete and provides for separate sessions for the discussion of gray iron, steel and malleable iron topics. Three symposiums have been scheduled, namely "Military Stores", "After-Treatment of Castings to Improve Their Physical Characteristics" and "Refractories". The opening meeting on Monday afternoon, Sept. 24, will be a joint session of the American Foundrymen's Association and the American Institute of Metals. Throughout the remainder of the week, ending with Friday, Sept. 28, only morning sessions will be held and the same plan will be followed, which proved so satisfactory at Cleveland last year. It is probable that simultaneous sessions of the malleable and gray iron and steel sections will be held Wednesday, Thursday and Friday. The exhibition will be formally opened Tuesday morning, Sept. 25, and will close Friday evening.

Headquarters for the American Foundrymen's Association will be at the Copley-Plaza hotel, although the meetings will be held in the Mechanic's building. The American Institute of Metals will have its headquarters at the Hotel Somerset and its meetings either will be held at this hotel or in the exhibition building.

The foundrymen of New England have completed a strong organization to provide for the reception and entertainment of the visitors. While their plans have been outlined only tentatively, the program includes a boat trip around Boston harbor, theater party, a visit to one of the big league parks to witness a professional ball game, ladies' luncheon and plant visitation. The complete list of committees appointed by the New England foundrymen, follows:

Executive Committee

W. J. Lavelle, chairman, New England Coal & Coke Co., Everett, Mass.

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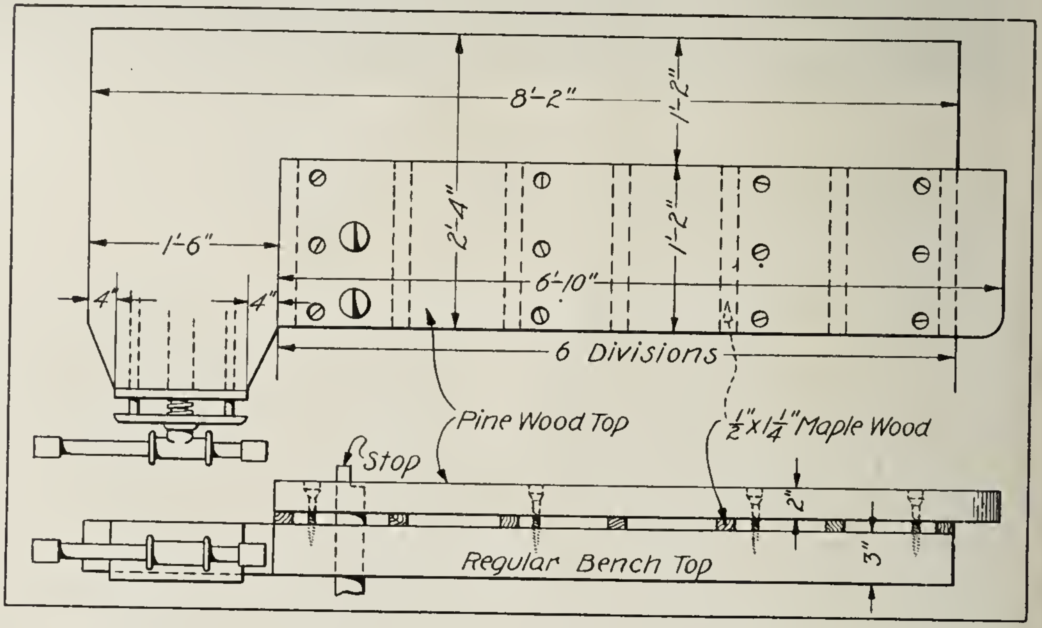
A Top for the Patternmaker's Work Bench

By M. E. Duggan

Patternmakers usually find that it is almost impossible to do good work on a bench whose top surface is warped and twisted. Most employes of the pattern shop do not take kindly to frequent dressing of the bench top, but it is generally agreed that a smooth polished surface tends toward better work and encourages the patternmaker to exert more care and accuracy in making patterns.

The standard practice in most pattern shops is to fasten a pine board on the regular bench top. As this board is fastened directly to the top of the bench, there is no chance for air to circulate against the lower surface of the board. This lack of circulation causes the exposed top surface to dry and contract, producing a concave surface.



METHOD OF FASTENING BENCH TOP SO THAT IT WILL NOT WARP

The warping of the bench top can be avoided by attaching the pine board to the bench in the manner shown in the accompanying illustration. The cleats provide for an air space of 2 inches, which insures equal exposure of the wood on all surfaces and thus prevents uneven contraction.

Open-Flame Furnace for Melting Statuary Bronze

Oil-fired open-flame melting furnaces have been used successfully for melting art bronze at the plant of the Gorham Mfg. Co., Providence, R. I. Two of these furnaces recently were installed in this foundry by the Monarch Engineering & Mfg. Co., Baltimore. Several additional furnaces of this type will be added to the present furnace equipment. One of the notable pieces of statuary recently cast by the Gorham company with bronze melted in this open-flame furnace was that of Phillips Brooks, a prominent Episcopal bishop of New England; 4,850 pounds of metal were required for casting this statue. The metal was melted in two open-flame furnaces which were charged at 12:10 p. m. and the metal was poured at 3:45 p. m.; 7½ minutes elapsed from the time the first metal entered the mold until it was filled.

Cores for Steel Castings

Question:—Can you give us some information regarding the best sand and binder to use for heavy steel castings? We are using silica sand with flour and oil binder, which is giving good results on medium weight castings but does not seem to work well on heavier sections.

Answer:—Flour is not a desirable addition to a sand facing for metals with a high melting point such as steel, nickel, etc., because it generates considerable gas. Carbonate or sulphate of lime, is often present, and these, at a steel melting temperature, exert a fluxing action on the sand, causing it to fuse onto the casting, leaving pit holes because in fusing it swells into small bubbles. Use silica sand containing over 97 per cent silica and bond with high grade fire clay and molasses water. Mill the sand thoroughly. Mix the sand and clay in such proportions as will produce a molding mixture that will pack when squeezed in the hand, like good molding sand. For dry sand work it may be necessary to add a little flour to bond the sand when dried. Paint the molds with silica wash for dry sand work.

The Lewis Machine Co., Cleveland, formerly located at 830 Long avenue, has removed its plant to 6303 Central avenue.

Early Stove Manufacture in the United States

The Oldest and Best Preserved Cook Stove in America is Described and Illustrated and the Method of Molding is Discussed

By W J Keep

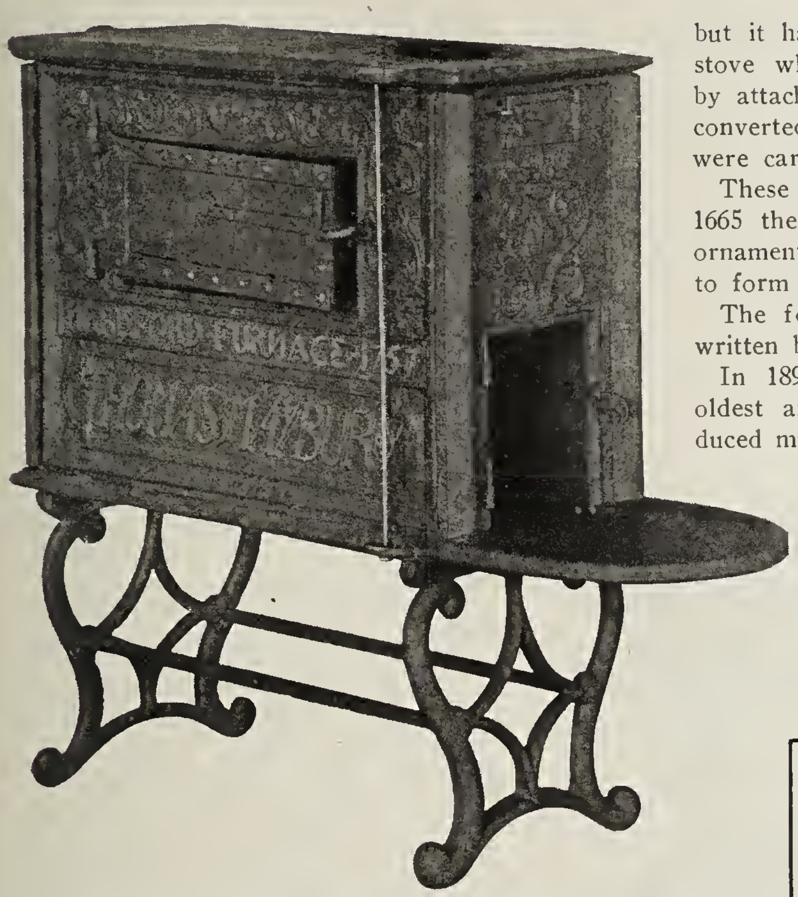


FIG. 1—COOK STOVE MADE AT HEREFORD FURNACE, PA., IN 1767 AND CAREFULLY PRESERVED BY THE MICHIGAN STOVE CO.

QUESTION:—When were the first cast iron stoves made in the United States, and what was the composition of the iron used?

Answer:—The first blast furnace in America was erected at Lynn, Mass., in 1644, and smelted bog ores with charcoal. At the Essex museum, Salem, Mass., is a cast iron fireback made at this furnace, which contains the inscription cast thereon, entitled, "Pickering 1660". This fireback was found in the Pickering house in Salem and probably is the oldest American casting connected with the burning of fuel for domestic purposes which thus far has been found.

The first charcoal blast furnaces in Pennsylvania were erected between the years 1720 and 1750. In 1742, Dr. Franklin's open front stove was made at the Warwick furnace. During these years the Pennsylvania Germans brought to this country "five-plate stoves", otherwise termed "jamb stoves". The five castings consisted of a bottom, top, two sides and the back, which were ornamented with Biblical pictures. These castings were held together by one rod through lugs in the top and bottom. The open end was built into the back of the fireplace of an adjoining room and extended about 2 feet into the room behind the fireplace. It had no legs and the bottom was about 15 inches from the floor. The stove obtained its heat by radiation from the fire, and to increase the heat, burning coals could be shoveled into it.

Sometimes a jamb stove was erected in an outer wall, the open end being outdoors. A fire could be built in it, but it had no pipe or chimney. By adding an end to the five-plate stove which contained a door for the introduction of wood, and by attaching a smoke pipe and setting the stove on a stand, it was converted into a "six-plate" or box stove. Prior to 1750, these stoves were carved and contained illustrations of Biblical subjects.

These stove were made for a period of about 10 years, when in 1665 the English brought to Pennsylvania the same kind of stoves ornamented with scroll work. However, the English added four plates to form a small oven and these were called "ten-plate" stoves.

The foregoing information was gathered from *The Bible in Iron*, written by Henry C. Mercer.

In 1892, the Michigan Stove Co., Detroit, offered $100 for the oldest and best preserved cook stove made in America. This produced much information regarding early stoves which otherwise would have been lost, and the Michigan Stove Co. obtained one of these 10-plate stoves made at Hereford Furnace, Pa., in 1767. This stove was made by the proprietor of this furnace, Thomas Mayburry, and it was exhibited by the Michigan Stove Co. at the World's Fair in Chicago in 1893. In its present preserved form, this early cook stove is illustrated in Fig. 1, and Fig. 2 shows the details of its construction. This stove, cast only two years after

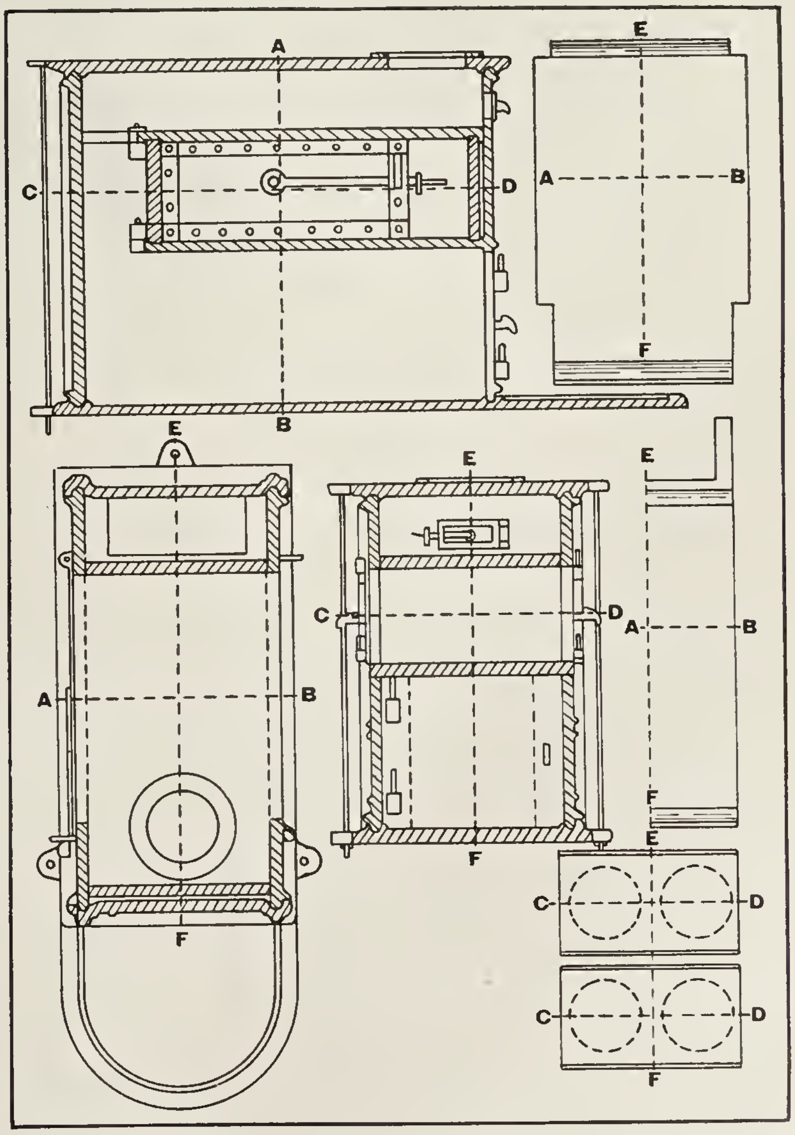


FIG. 2—DETAILS OF CONSTRUCTION OF THE COOK STOVE ILLUSTRATED IN FIG. 1

the introduction of this type, was made in open sand on the floor of the furnace cast house from iron as it was tapped out of the stack. The mold was made by pounding a board into the sand, on one side of which the design was carved. The iron was poured into and flowed over the mold, and the casting was from ½ to ¾-inch thick. This stove was known as the *small* size and weighs 372 pounds. Two other sizes also were made, known, respectively, as *medium* and *large*. The plates were held together by three rods on the outside. The doors were made from wrought iron by a blacksmith, which he reduced to a thickness of about ⅛-inch by hammering and this same thickness of metal was used for the pipe. Rolled sheet iron was not available until many years later. Only one of the large doors remains and this is rusted through just above the lower band.

The first American cook stove which was worthy of the name was patented by W. T. James on April 26, 1815, and was made and sold by him at Troy, N. Y. An etching of this stove is shown in Fig. 3.

The catings were poured in flasks at a blast furnace near Philadelphia and were shipped to Troy, N. Y., where they were assembled. It was supposed that the only iron suitable for stoves was the metal tapped from the blast furnace.

In the early days, stoves were peddled from wagons and produce was taken in payment as there was very little money in circulation at that time. Complete stoves were shipped by water to Philadelphia to pay for the castings made in that city.

The foregoing information is from the manuscript of the "History of Stoves," by the author, and in a later issue of *The Foundry* the first American base burning stove will be illustrated and described.

Brick Made From Ashes

The Wagner Fire Brick Co., Scranton, Pa., is completing a plant near that city which will have a capacity for producing 50,000 fire brick daily, and will be placed in operation about the middle of June. The product will be of an unusual character, comprising fire brick and fireproof building brick made from coal ashes by a patented process developed by Earl V. Wagner, formerly chemist for the Lackawanna and Erie railroads and for the Scranton Electric Co. Several thousand brick already have been made and were subjected to thorough tests by the Spencer Heater Co. and National Paving Co., Scranton, and the Alleghany Window Glass Co., Port Alleghany, Pa. The results of these tests are claimed to prove the coal ash brick superior in heat-resisting qualities to clay brick. The Wagner brick have a fusion point of from 2,600 to 3,250 degrees Fahr., depending upon the binder; a crushing strength of 1,300 pounds or more per square inch and the porosity is 22.5 per cent. The binder employed is a combination of magnesia, alumina, sodium, silicate and crude fibrous asbestos. The company's plant is designed along modern lines and is being equipped by the American Clay Machinery Co., Bucyrus, O., with a full line of automatic and sem-automatic brick machinery.

Magnesite Bottoms for Electric Furnaces

A new method of making magnesite bottoms for electric furnaces, is the subject of a patent granted to James H. Gray, of the United States Steel Corporation, New York. The process, as described by the inventor, follows:

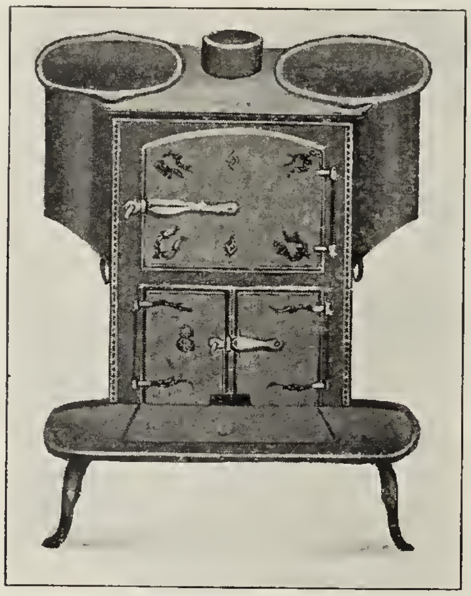


FIG. 3—COOK STOVE PATENTED BY W. T. JAMES IN 1815 AND MANUFACTURED AT TROY, N. Y.

"I first place a layer of magnesia bricks on the bottom of the shell of the furnace and then place a layer of granular magnesia one or two inches thick on the bricks. I then heat the furnace and the magnesia to such a temperature that the latter becomes a good conductor of electricity. This may be done in any one of several ways. For example, a flame furnished by fuel oil may be introduced into the furnace, or a bed of coke may be laid on the magnesia and the electric current passed through the coke from the electrodes in the manner described to heat the same to incandescence, or lengths of electrodes may be laid on the bottom and the regular electrodes lowered to strike arcs therewith and to pass an incandescing current through these special lengths. Any one of these methods will bring the main electrodes to a white heat and will furnish sufficient heat in the furnace to bring the magnesia to a temperature at which it becomes a sufficiently good conductor of electricity. When this temperature is reached the electrodes are lowered to the bottom of the furnace (removing any coke or similar material which may have been introduced for the initial heating) and arcs are struck between the electrodes and the now conductive magnesia. The arcs and the current passing through the magnesia increase its temperature until it becomes molten or semi-molten or pasty. When this condition has been obtained more magnesia in granular form is introduced about the electrodes and this in turn becomes conductive as it receives heat both from the electric arcs and from the heated walls and atmosphere of the furnace. As the material banked about the electrodes becomes conductive, the electrodes are gradually raised so as to maintain the necessary resistance at the arcs for the desired number of amperes of current to flow through the electrodes, the raising of the electrodes being accomplished either by hand or by automatic regulators such as are now generally employed for regulating the height of electrodes in such furnaces. The hearth is thus built-up to the desired depth and shape in a sound and reliable monolith, by throwing in new material progressively at such points as may need building up."

Semi-Steel Castings

By *W. J. Keep*

Question:—In making semi-steel castings, is it preferable to use horseshoes or boiler punchings and shearings? I understand the former are made by the basic process. I would like to know what takes place metallurgically in the basic and acid processes of making steel.

Answer:—The process by which the steel is made will have no influence on your semi-steel. If the fluid metal does not lie still in the mold or is not fluid enough, or contains blow-holes, place about 0.1 per cent pure aluminum in the ladle before you pour iron into it.

The terms "basic" and "acid" apply to the lining used in the furnace. The shape of the furnace is also different and the pig iron used also varies in some respects, but chemically the final product is not expected to differ materially. Basic pig is a low-silicon and low-sulphur iron, the standard being 1.00 per cent silicon and sulphur under 0.05 per cent. Acid or bessemer pig contains phosphorus under 0.1 per cent; 1.00 to 1.25 per cent silicon and sulphur under 0.05 per cent.

The Care to be Exercised in Vibrator Operation

This Valveless Engine is an Important Piece of Equipment Which Should Receive More Than the Ordinary Care From the Foundryman

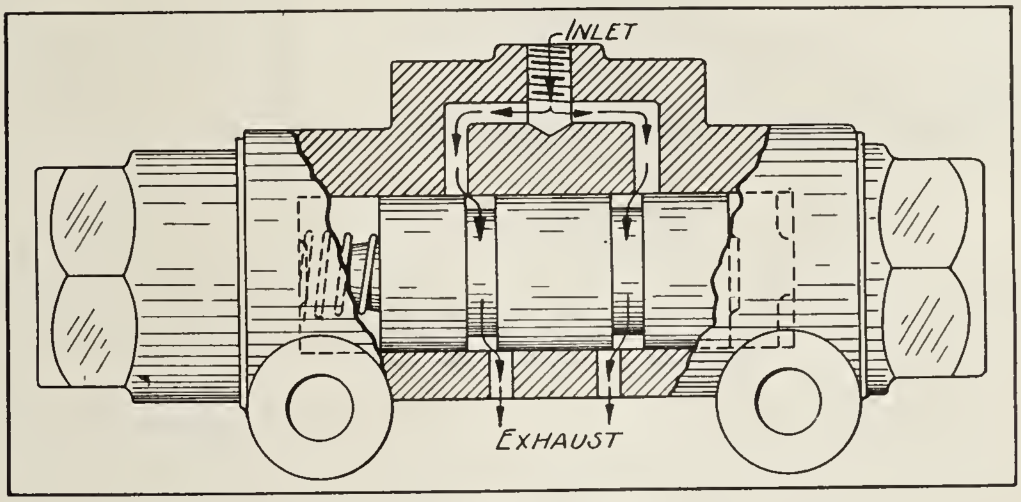
By Harry H Barclay

IN THE gradual transition from hand to machine molding, foundry vibrators are among the least understood and most abused of the many accessories now in general use in modern casting plants. How many molders know that a vibrator is practically a valveless engine, so delicately adjusted and perfectly fitted, that a few grains of sand or a particle of the inner lining of the air hose will clog the inlet ports and put it out of business? Some of our best mechanics expect a machine of this nature to run indefinitely without care, cleaning or oil—and to be practically indestructible. Some of the experts in the electrical profession have been asked to tell us how many blows a vibrator hits per minute, or to rig up an electrical contrivance to count the blows, but they have never been able to get accurate results. A well-known molding machine builder pasted a long strip of white paper on the bed of a planer and fastened a marker with a coiled spring on one head of a ¾-inch vibrator, which was held rigidly as close to the paper as possible. while the bed of the planer moved along; the dots made on the paper in a given length of time were counted and the vibrator hit nearly 14,000 blows a minute. To get this rapidity of motion, which means that the vibrator plunger has to come to a dead stop and then start up again 28,000 times a minute, the vibrator must be designed so it can hang on a dead center and blow through on both ends; that is, by placing the plunger centrally, as shown in the accompanying illustration, the air can come through both inlet ports at the same time, pass through the air ports in each end of the plunger and out of the exhaust ports, while the plunger remains stationery.

This valveless engine, which is what a vibrator really is, does not even have a flywheel to carry it over the center, but depends on the momentum acquired before the dead center is reached to complete the stroke. To acquire this speed, the air must be admitted quickly and should be of sufficient volume to fill the air chamber instantly; the plunger will then carry over the dead center with sufficient velocity to hit a good blow regardless of the air cushion already waiting to carry the plunger on the return stroke. All vibrators will run better without a spring. Its function is solely to put the plunger in the correct starting position. After the plunger gets a start, the spring is a detriment. An experience of over 12 years devoted entirely to vibrators under almost every conceivable condition of operation leads to the conclusion that at least 75 per cent of all vibrator troubles are caused by placing the starting valve too far away from the vibrator and using a valve that admits the air slowly instead of with a snap. To fill a hose line full of air, even though the line be only a few feet long, lets the weak pressure in front get the vibrator on the center before enough resistance is formed to equalize the pressure.

The ideal wearing surface is a hardened tool steel plunger running in a cast iron or semi-steel body, the bearing surface of which soon gets glazed and smooth, while a hardened plunger running in a hardened and ground steel body frequently freezes to the body unless oiled at least once every day. The rust caused by the moisture in compressed air will adhere to both the body and plunger which will rust the two so tightly together that it is frequently necessary to take both heads off the vibrator and drive the plunger out with a drift and then lap the plunger in again. Rust has no affinity for the glazed surface of hard semi-steel and will not adhere to it. A vibrator of this material, which ran continuously for 260 hours without a drop of lubrication, was found to be in perfect condition when the test was completed.

A drop-forged chrome-vanadium steel body of the same shape and size had to be oiled every five hours, as it was constantly running hot, but was torn apart by the vibrations between the 64th and 65th hour of the test. A satisfactory vibrator for plate work should be strong enough to last at least two years, operating 10 hours per day, yet light enough not to be a burden to the molder. It must start instantly and do snappy work, and the least we can do to help it along is to give it care and a fair chance.



VIBRATOR CONSTRUCTION SHOWING INLET AND EXHAUST PORTS

A New Core Buster

George Oldham & Son, Philadelphia, are manufacturing a pneumatic tool known as a core buster, which is designed for cutting out cores quickly and economically. By the use of this tool heavy cores in large castings can be removed in much less time than is required when the work is done by hand, and it is claimed that one man with this tool can do the work of three or four not so equipped. The chisel is held in a retainer by a spring lock washer and the air-cushioned chisel bushing is held in place by a supply of live air only when the chisel is in operation. By this pneumatic feature the shock is absorbed.

The City Pattern Works, Detroit, manufacturer of wood and metal patterns has been compelled to increase its facilities and has moved into larger quarters at 144 to 156 Congress street.

THE FOUNDRY

A monthly journal devoted to all branches of the foundry trade

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Contents

How We May Conserve Our Metal Resources.................. 209
Molding Sand Gets Right of Way to Oct. 15.................. 214
Keeping Down Operating Expenses in a Small Gray Iron Foundry 215
Castings from Acid and Basic Electric Steel.................. 220
Losses in Melting Cast Iron.................. 222
The Foundry Behind the Automobile.................. 223
Government Prices for Zinc.................. 231
Rennerfelt Furnaces Sold.................. 231
The Electric Furnace in the Steel Casting Plant.................. 232
A Difficult Bronze Casting Molding Job.................. 234
Mine Pump Impellers.................. 235
Utilizing Scrap Babbitt Metal.................. 236
Difficulties in Casting Bronze Bushings.................. 236
Bronze Mixture to Resist Acetic Acid.................. 236
Analyses of Bearing Metals.................. 236
Utilizing Thin, Rolled Brass Scrap.................. 236
White Brass for Automobile Door Handles.................. 236
The Evolution of the Die-Casting Process.................. 237
Helmet for Arc Welders.................. 243
Testing Engineers Outline Comprehensive Program.................. 243
A Self-Skimming Ladle for Pouring Steel for Castings.................. 244
Boston Prepares for Founders' Week.................. 245
A Top for the Patternmakers' Bench.................. 246
Open-Flame Furnace for Melting Statuary Bronze.................. 246
Cores for Steel Castings.................. 246
Early Stove Manufacture in the United States.................. 247
Brick Made From Ashes.................. 248
Magnesite Bottoms for Electric Furnaces.................. 248
Semi-Steel Castings 248
The Care to be Exercised in Vibrator Operation.................. 249
Are Conventions Worth While in War Time?.................. 250
Personal 251
Book Review 251
Charles Vickers, Metallurgical Editor of The Foundry.................. 251
What the Foundries are Doing.................. 251
New Trade Publications.................. 252

Are Conventions Worth While in War Time?

PROMPTED by the belief that the calling together of the members of a national organization of engineers, business men, or tradesmen has a distressing effect upon the work of preparing the nation for war, a number of well known railway associations have postponed their annual conventions. This action has raised the question, "Are conventions worth while in war time?"

In the light of events that have transpired during the past few weeks, the question may be answered in the affirmative. Beginning May 2, members of the American Electrochemical Society convened at Detroit in one of the most successful meetings of the organization. The American Society of Mechanical Engineers and the National Machine Tool Builders' Association held meetings at Cincinnati during the week of May 21. It can safely be said that these meetings were the source of more valuable information regarding the manufacture of munitions than had previously been imparted to American engineers and manufacturers. On May 25 and 26 at New York the American Iron and Steel Institute devoted much time and attention to the problems of steel manufacturers in meeting the exigencies of war.

The success attending the meetings mentioned in the foregoing paragraph is sufficient proof that conventions are worth while, yet it is possible to go further and to show that such meetings are a positive necessity. England and France have found that the development of the iron and steel and kindred industries has been hastened by the war. It is fast dawning upon the authorities that the dissemination of information which assists in prosecuting the war more vigorously is best effected through the medium of the engineering and technical organizations. This explains why in war-fatigued England, such societies as the British Foundrymen's Association, the Institute of Metals, and the Iron and Steel Institute, and the various engineering organizations, are more active now than before the war.

The entrance of the United States into the war has added to the burden of manufacturers. There is more need now that ever before for a thorough discussion of business conditions, engineering topics and operating problems. For this reason, the 1917 conventions of the American Foundrymen's Association and the Institute of Metals have a more definite and valuable function to perform than ever before. The September meetings will render a distinct service to the country in placing before the foundrymen the very information they must have in order to properly perform their part in the national program of successfully waging war.

Prices of iron and fuel are still seeking higher levels. No. 2 foundry pig iron is quoted in the leading trade centers as follows: Pittsburgh, $43.95; Chicago, $43; Cleveland, $43 to $45; Buffalo, $43 to $45; Birmingham, $36 to $40; and Philadelphia, $42.50 to $43. Basic iron is held at $42.95, and bessemer at $45.95 to $48.95, Pittsburgh. Lake Superior charcoal iron is quoted at $49.25 to $51.75, Chicago. Prompt coke is firm at $9.50 to $10, and for second half delivery, $8.50 to $9.50, at the ovens.

Personal

Augustus S. Blagden, formerly vice president of the American Malleables Co., Buffalo, has been elected president.

George H. Rolinson has been appointed superintendent of the foundry operated by The Connersville Blower Co., Connersville, Ind.

E. C. Bauer who has been connected with the sales department of the American Manganese Steel Co., Chicago, has been appointed assistant to the vice president.

Joseph C. Sanders, formerly vice president of the American Foundry & Mfg. Co., St. Louis, has been elected president to succeed the late Barney H. Sanders.

W. J. Scholes has been appointed superintendent of the foundry branch of the General Motors Co., located at Stockton, Cal., where gas tractors are manufactured.

Ralph Donaldson, Pittsburgh, has been appointed superintendent of the Bucyrus, O., plant of the Ohio Steel Foundry Co., Lima, O., succeeding C. W. Lytle, resigned.

G. S. Evans has resigned as superintendent of the foundry of the Lenoir Car Works, Lenoir City, Tenn., and has been succeeded by H. N. Curd.

C. G. Howe has been appointed New England sales representative of the E. J. Woodison Co., Detroit, manufacturer of foundry supplies and equipment. Mr. Howe will travel out of Boston.

W. C. Hammond, assistant manager of the Standard Cast Iron Pipe & Foundry Co., Bristol, Pa., for a period of nine years, has been appointed manager of the Wm. E. Hill Co., Kalamazoo, Mich.

At the annual meeting of the Newark Foundrymen's Association, officers were elected as follows: Arthur E. Barlow, president; George Krouse, vice president; John Campbell, treasurer, and Ulrich Eberhardt, secretary.

George Mitchell, of the Pittston Stove Co., Pittston, Pa., was re-elected president of the Stove Founders National Defense Association at the annual meeting of this organization, held in Chicago on May 8.

Fred Sill, of the Sill Stove Works, Rochester, N. Y., was elected president of the National Association of Stove Manufacturers at its forty-sixth annual meeting held at the Congress hotel, Chicago, May 9 and 10.

George W. Knotts, Pittsburgh, has been appointed manager of the William Tod, Lloyd-Booth and Oak Street shops, Youngstown, subsidiary plants of the United Engineering company.

Charles H. Booth has resigned as chairman and member of the executive committee of the United Engineering & Foundry Co., Pittsburgh, because of ill health. However, he will continue as a member of the board of directors.

John D. Hurley, vice president of the Independent Pneumatic Tool Co., Chicago, has been elected president to succeed the late James Buchanan Brady. Ralph S. Cooper, manager of the New York office of this company, was elected vice president to succeed Mr. Hurley and Robt. T. Scott, manager of the Pittsburgh branch was elected a director and member of the executive board.

Book Review

Annual Chemical Directory of the United States, edited by B. F. Lovelace; cloth; 305 pages, 6 x 9 inches; published by Williams & Wilkins Co. and furnished by *The Foundry* for $5 net.

In the past two years the United States has been thrown on its own resources as far as chemical products are concerned. The progressive spirit which is pregnant throughout the chemical industry is evidenced in the publication of "The Annual Chemical Directory of the United States". This is the first edition of the book, and a review of its contents will give an idea of its value. Section I contains a list of the chemical products manufactured in the United States with the names of the manufacturers. Names of American manufacturers and dealers in apparatus and equipment, machinery and mechanical supplies useful or essential for scientific and technical laboratories, industrial plants and organizations are given next. Other sections list professional chemical firms; federal, state, municipal, industrial and professional laboratories, American and foreign colleges, offering courses in chemistry; experiment stations in the United States and the principal foreign countries; federal and state officials of dairying, foods, drugs, etc.; American and foreign technical and scientific societies; also American and foreign chemical journals and important chemical books published in 1916-17. Chapter X summarizes the new and important happenings in the field of chemistry in 1916, while Chapter XI tells of new devices, methods and appliances for handling industrial chemical problems.

Charles Vickers, Metallurgical Editor of The Foundry

The editorial staff of *The Foundry* has been further strengthened by the appointment of Charles Vickers, Niagara Falls, N. Y., as metallurgical editor. For a number of years, Mr. Vickers, who has had a wide experience as a brass foundryman, was associate editor of *The Foundry*, and five years ago he resigned to accept a position with the Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Throughout this period, however, he was a regular contributor to *The Foundry*, and conducted the department devoted to "The Problems of the Brass Founder". In addition to his editorial duties, Mr. Vickers will engage in consulting work in the brass foundry field. His wide experience as a practical brass foundryman, chemist and metallurgist, enables Mr. Vickers to bring to his work a wide knowledge of the uses of non-ferrous metals and their manufacture and conversion into finished articles of commerce.

What the Foundries Are Doing

Holt Brothers, Concord, N. H., are building a foundry, 60 x 175 feet.

Robert D. Alger, West Bridgewater, Mass., will erect a grey iron foundry, 50 x 70 feet.

The Elmira Foundry Co., Elmira, N. Y., will erect a foundry, 90 x 300 feet.

The Reading Knob Works, Reading, Pa., is having plans prepared for an addition to its foundry, 50 feet square.

The Illinois Malleable Iron Co., Chicago, contemplates the erection of an addition to its foundry, 154 x 325 feet.

The St. Maurice Foundry Co., Three Rivers, Que., Can., is erecting a foundry at a cost of approximately $30,000.

The Northwestern Brass & Aluminum Co., Rochester, N. Y., is having plans prepared for the erection of a brass foundry.

The Plymouth Motor Castings Co., Plymouth, Mich., shortly will begin the erection of an extension to its foundry, 50 x 420 feet.

The Duriron Castings Co., Dayton, O., will erect an addition to its plant at an estimated cost of $7,000.

The Favorite Stove & Range Co., Piqua, O., is extending the capacity of its plant by the erection of a new building.

The Weatherly Foundry & Machine Co., Weatherly, Pa., is erecting an extensive addition to its plant.

The Aluminum Castings Co., Cleveland, is erecting an addition to its Buffalo plant, 130 x 260 feet.

The Sheffield Car Co., Three Rivers, Mich., will erect an addition to its foundry, 128 x 378 feet.

The Roberts Brass Co., Milwaukee, manufacturer of automobile specialties will build a new plant, 40 x 100 feet.

The Huntington Steel Foundry Co., Huntington, Ind., will erect a 2-story addition to its plant to be used as a pattern shop.

Wettlaufer Brothers, Toronto, Can., will build a foundry and machine shop at Frederickton, N. B.

The Taylor Coupler & Steel Castings Co., of which J. C. Taylor, 542 Ohio Bldg., Toledo, O., is president, will erect a foundry at Ironville, O.

Walter B. Taylor, Worcester, Mass., manufacturer of brass castings has awarded a contract for the erection of a new foundry, 50 x 80 feet.

The capacity of the Lansdale Foundry Co., Lansdale, Pa., is being increased considerably by the erection of an additional core shop, shipping room, machine shop, etc.

The American Radiator Co., Buffalo, will erect an addition, 100 x 200 feet, to its Pierce plant at Elmwood and Hertel avenues and the New York Central Railroad belt line.

The Wadsworth Foundry Co., Wadsworth, Ohio, is erecting a gray iron jobbing foundry, 60 x 80 feet. The company is capitalized at $15,000 and C. C. Paterson is president and general manager.

The Hammond Malleable Iron Co., Hammond, Ind., will erect an addition to its plant, 70 x 280 feet. A 25-ton furnace will be installed. A shipping room, 100 x 160 feet, and a new office building also are under construction.

The General Electric Co., Schenectady, N. Y., will erect another foundry, 125 x 525 feet, one and two stories high, with wings 36 x 250 feet. The approximate cost of this plant is $400,000.

The Miller Carburetor Co., Los Angeles, Cal., contemplates the erection of a new plant for the manufacture of aluminum crankcases for automobiles and aeroplanes. H. A. Miller is president.

The National Engineering & Equipment Co., Seattle, will erect a new plant which includes a foundry, 80 x 100 feet; pattern shop, 20 x 30 feet; pattern storage, 20 x 32 feet and machine shop, 80 x 150 feet.

The Three Rivers Casting Co., Three Rivers, Que., Can., will build a foundry at an approximate cost of $35,000. A large amount of equipment will be purchased. A. B. Charleton is manager.

The Columbia Bronze Foundry Co., Camden, N. J., has been incorporated with a capital of $10,000 and a plant will be erected for the manufacture of brass and bronze castings. William Early, Frederick T. Hyde and A. J. Weeks are the incorporators.

The Light Mfg. & Foundry Co., Pottstown, Pa., manufacturer of aluminum specialties, is having plans prepared for an addition, 50 x 110 feet. The erection of two 3-story extensions, 30 x 175 and 50 x 200 feet, also are being considered.

The Aluminum Castings Co., Cleveland, will erect a new foundry and finishing plant at Manitowoc, Wis., 200 x 300 feet in size. The company's existing plant at Manitowoc recently was sold to the Aluminum Goods Mfg. Co., which takes possession when the new foundry is completed, Oct. 1.

The Western Malleable Co., Beaver Dam, Wis., is making a number of extensions and improvements. The core room of shop No. 3 is being rebuilt and is being converted into a 2-story pattern shop. Two truck ovens and two ovens of the drawer type will be installed in shop No. 3.

The Evinrude Motor Co., Milwaukee, has purchased a 10-acre site for a new plant which will consist of a gray iron and brass foundry and machine shop. The plans are being prepared by the Federal Engineering Co. The foundry will be 80 x 200 feet and will be equipped with a 60-inch cupola.

The Jewell Steel & Malleable Co. of California has been incorporated with $50,000 capital to erect a plant at San Francisco for the manufacture of steel and malleable castings. W. E. Jewell, of the Jewell Steel & Malleable Co., Buffalo, and A. Haase, William Lauten and C. S. Maltby, all of San Francisco, are interested in the new project.

The Standard Steel Castings Co., Cleveland, will enlarge its plant by the erection of an addition which will provide 15,000 additional square feet of floor space. Plans also are being prepared for another steel foundry to be erected in five units, each with a capacity of 1,000 tons of steel castings per month. Converters and electric furnaces will be installed.

General Industrial Notes

The Board of Education of Oakland, Cal., will increase the equipment of its school foundry.

The Superior Steel Casting Co., Benton Harbor, Mich., has purchased a tract of 17 acres to provide for future extensions.

The New England Foundry & Machine Co., Campello, Mass., has been incorporated with $10,500 capital. The directors are John G. Grant, Victor R. MacBain and L. F. Parks.

The Manitowoc Foundry & Machine Co., Manitowoc, Wis., has purchased approximately $5,000 worth of shop equipment.

The Modern Steel Casting Co., Milwaukee, has been incorporated with $25,000 capital by A. J. Deuser, Fred W. Biehn and William T. Hardy.

The Union Machine Works & Iron Foundry, Inc., Philadelphia, manufacturer of gray iron and steel castings, has purchased the buildings adjoining its plant, which occupy a floor area of 108 x 157 feet.

The International Castings Co., Rome, Ga., has been incorporated with $10,000 capital, by W. A. Smith and E. W. Kreider, to engage in the manufacture of stoves, ranges and hollowware.

The Donning Carburetor Corporation, Esopus, N. Y., has been incorporated with $300,000 capital to manufacture carburetors and engines. George W. Donning, R. Grant and A. K. Barker are the incorporators.

The Belding Foundry Co., Belding, Mich., has been incorporated with $25,000 capital and will take over the company of the same name, formerly owned by R. A. Stokoe. The plant will be enlarged and considerable new equipment will be installed.

The Singer Mfg. Co., Elizabethport, N. J., manufacturer of sewing machines, contemplates re-opening its foundry at Netcong, N. J., and it is also reported that its blast furnace at that place shortly, will be lighted.

The Van Wert Foundry Co., Van Wert, O., has been incorporated with $15,000 capital to take over the Van Wert Foundry plant and, it is reported also, the shop of the Delphos Foundry Co., Delphos, O. R. F. Marsh will be manager.

The Quincy Steel Casting Co., Quincy, Mass., has been incorporated with $25,000 capital by Roy G. Lundin, Dorchester, Mass., who has been elected president and treasurer, and Theo. Von Rosenvinge and O. F. Werstrom.

The Hercules Steel Casting Co., Milwaukee, shortly will select a site for its proposed foundry which will cost approximately $100,000. The offices of the company are in the Free Press building and E. B. Gennrich is secretary.

The Stroh Casting Co., Detroit, manufacturer of gray iron castings has succeeded the New Standard Foundry Co., of that city. During the past three years the melting capacity of this company's plant has been increased from 10 to 75 tons daily. A specialty is made of automobile castings.

The Lakewood Engineering Co., Cleveland, has taken over the plant of the Duplex Foundry & Mfg. Co., Elyria, O., which will continue to be operated under its present name. Considerable new equipment will be installed including a cupola. A. L. Ehrbar, formerly connected with the Dunham Co., Berea, has been elected president of the Duplex Co.

The Beckemyer Foundry Co., has been organized at Beckemyer, Ill., with a capital of $8,000 to engage in the operation of a foundry for the production of gray iron, semi-steel, brass and aluminum castings. A plant now is being erected, the main building of which will be 60 x 100 feet. The incorporators are H. O. Briefield and W. L. Timmons and W. G. Keller has been appointed general manager and superintendent.

The Bilton Machine Tool Co., Bridgeport, Conn., manufacturer of gray iron castings, machinery and tools, has been organized by the consolidation of the Standard Mfg. Co., and the Parsons Foundry Co., both of Bridgeport. The Standard Mfg. Co. was established in 1905 and the Parsons Foundry Co. in 1871. C. E. Bilton is president and treasurer of the new company.

NEW TRADE PUBLICATIONS

COMPRESSORS.—A 20-page, 6 x 9-inch catalog devoted to duplex steam-driven air compressors for the general industrial application of compressed air has been issued by the Ingersoll-Rand Co., New York. Tables of sizes and capacities are given and the catalog is thoroughly illustrated to show the machine in detail.

PNEUMATIC DRILLS. — The Ingersoll-Rand Co., New York, in a 40-page, 6 x 9-inch catalog, illustrates and describes a large variety of types and models of pneumatic drills and gives recommendations as to the particular character of the work to which they are adapted. Each tool is illustrated and tables are included giving the sizes and capacities of each tool.

BLAST GATES.—A new type of air-tight blast gate to control the air supplied to oil and gas furnaces, blacksmith forges, blast pipes, miscellaneous blowing operations, heating and ventilating work, etc., has been put on the market by the W. S. Rockwell Co., 50 Church street, New York. This gate is made of a casing in two parts containing a slide operating entirely within the casing. The slide is made of hard rolled brass and moves in a machined runway with just enough clearance to permit movement. The face of each half of the casing is also machined, thus forming an air-tight joint. The slide is moved by a handle which extends outside the casing through a stuffing box. The casing is tapped for standard wrought iron pipe, or may be provided with nipples for connecting with sheet iron pipe.

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What the War Has in Store for the Foundry Trade

American Foundrymen Will Be Called Upon to Solve New Problems in Producing Castings for the Government's Huge War Program

READJUSTMENTS in trade were predicted as a natural result of the entry of the United States in the European conflict. The foundry industry already has been affected by these changes, but a survey of the situation indicates that manufacturers of castings have benefitted and the total melt has increased considerably. Almost immediately after the declaration of war, the wave of economy which spread over the country enmeshed the automobile trade and the buying of pleasure cars began to wane. This was passed down the line to the makers of cylinders and other parts for motor vehicles, with the result that the melt in many shops was curtailed as high as 50 per cent.

However, to replace a large part of this business, the government contemplates the purchase of 76,000 motor trucks. and the aeroplane program more than promises to offset the loss in tonnage of motor car castings. In this readjustment, consideration must also be given to the heavy requirements of castings of all kinds for field artillery, and the gray iron foundries as well as the steel casting and brass plants have been beneficiaries. Other readjustments in the foundry trade are certain to occur from time to time, and while these may affect some branches of the industry temporarily, the wastage of war will more than compensate for this tonnage.

Cast Iron or Semi-Steel Shells

It was generally believed that our munitions experts would investigate the use of cast iron or semi-steel shells. It has been reported frequently that the Germans are using cast iron, or some similar material for high explosive shells, and the French are employing semi-steel for this purpose. It is doubtful, however, if any immediate progress in. this direction is going to be made in this country since the opinion has been expressed that the need for semi-steel for shell purposes does not exist here. In view of this statement it might be advisable to direct attention to the reported economies that may be effected by their use.

According to authoritative advice, the French are employing a bessemer converter metal for this purpose, which is exceedingly low in phosphorus and is difficult to obtain in this country at the present time. Low phosphorus pig iron and scrap constitute the cupola charge which produces metal by blowing in the converter. To this metal, in the ladle, is added one-third converter steel as blown and this constitutes the mixture from which thousands of high explosive shells have been made and are being cast in France.

Shells Cored-Out

These shells are cored-out, eliminating almost entirely the heavy expense and the time-consuming operation of boring by machine. Furthermore, the shells can be made in much less time than is required for producing them in steel. Time is conserved and the cost is greatly reduced, both elements of the greatest importance to us in our preparatory stage. Cast iron, or semi-steel, as it might be termed correctly, as used for shells in France, possesses all of the necessary physical properties for a metal for high explosive shell purposes. Cast iron is the ranking metal in the property of compression, and being brittle, it will shatter better than any other material that may be employed. It lacks elasticity, but this is imparted to it in the necessary amount by the addition of the converter steel. The problem of molding the shells involves no great difficulties and many machines are available that can be adapted for this purpose.

If the French process possesses any merits, these should be investigated in our speeding-up process and a commission should be sent to France to learn the facts. Steel shells are being cast successfully in this country, but these are being bored-out, whereas a large part of this expensive machine work might be eliminated by the judicious use of cores. Even if there are objections to the use of cores, their employment at least might be investigated. The American Navy, according to reliable reports, has used cast iron shells for practice purposes, and furthermore, these castings have been made in permanent molds. It is stated, on unquestioned authority, that Germany has used semi-steel for shell-making purposes for the last 15 years.

Low-Phosphorus Iron is Soaring

The possible drawback to the present employment of the French process is the scarcity of low phosphorus pig iron and scrap. No grade of iron has attained such a height in price within the memory of those now engaged in the industry, and the indications are that it will go still higher. One sale of a small lot of low phosphorus pig iron recently was made at $100 a ton and for delivery during the first quarter of next year, $82.50 per ton is asked by some eastern furnaces.

To overcome this disadvantageous position, if possible, foundrymen have sought the use of increasing amounts of scrap in their charges, until an all-scrap process has been developed that is giving satisfactory results. So sensitive is the iron market, however, that these increased purchases of low phosphorus scrap were felt immediately, with the result that prices began to sky-rocket. Within the last 30 days advances of $15 per ton have been made and in the east, where this acid steel process predominates, this scrap now is quoted at $52 per ton. Even at this price its use is more economical than pig iron, but further advances are anticipated which might put this material out of the running and in a class with low phosphorus pig iron.

The Future of the Trade

The future of both the pig iron and the scrap markets are giving foundrymen much concern. That higher prices will prevail is certain, since the production of pig metal is inadequate to meet the present needs. The requirements of steel products for the government are constantly soaring and with the steel production leaving the pig iron output far in the rear, the reason for increased scrap consumption and vaulting prices becomes apparent.

Electric Steel Output Increases 85 Per Cent

STEEL castings reached the peak of their production in the United States in 1916 with a total of 1,371,763 tons, which exceeds by 351,019 tons, the previous high point recorded in 1913, when 1,020,744 tons were made. In 1915 the output of the steel foundries was 866,824 tons and the increase over that year in 1916 was 504,939 tons, or 58 per cent. Basic steel castings almost doubled their total of the previous year, when 333,103 tons were made. In 1915 the output of acid steel was 402,229 tons and is in excess of basic steel, 69,126 tons. However, in 1916 the acid steel process fell below the total for basic with a production of 570,937 tons. The total acid and basic production was 1,176,449 tons, ac compared with the best previous output in 1913 of 910,216 tons. The converter steel process likewise showed a gain with a production of 142,791 tons as compared with 92,476 tons the previous year. Castings made by the crucible steel process, however, showed a big falling off in tonnage, with a total of 9,351 tons as compared with 14,756 tons in 1915 and a high point of 20,550 tons in 1912. This decline in the output of crucible steel castings may be attributed largely to the difficulty experienced in obtaining crucibles and to the high prices prevailing for these pots.

The tremendous increase in the application of the electric steel process is evidenced by the output of electric furnaces in 1916, which showed a production of 42,870 tons against 23,064 tons the previous year. This shows a gain of 19,806 tons, or 85 per cent. In 1909 the first statistics on electric steel castings production were available, when 306 tons were made. In 1913 this had grown to 9207 tons and the greatest advances in this practice were recorded in 1915 and 1916.

Alloy steel castings attained a total of 56,458 tons, of which 2200 tons were made by the basic open-hearth process, 26,134 tons by the acid open-hearth process, 30,833 tons by the basic process, 815 tons by the crucible process and 926 tons by the electric process. The accompanying tables give the production of steel castings since 1902.

The production of steel castings in Canada in 1916 totaled only 31,313 tons against 39,490 tons the previous year. Canada's entire steel production was 1,286,509 tons whereas the total for the United States last lear was 42,773,680 tons. The American Iron and Steel institute also has gathered data on the manufacture of cast iron pipe which totaled 1,214,333 tons in 1916 and 1,096,770 tons the previous year. Gas and water pipe constituted 874,129 tons of last year's total and fittings for this pipe, 60,497 tons. Soil and plumber's pipe totaled 206,494 tons and fittings therefore, 73,213 tons. The total production of fittings last year was 133,710 tons against 118,100 tons in 1915. The total output of cast iron gas and water pipe and fittings and soil and plumber's pipe and fittings in Canada, in 1916, was 43,850 tons, as compared with 53,700 tons the previous year, a decline of 9850 tons.

Production of Steel Castings in the United States

	Open hearth							
Years	Basic	Acid	Total	Bessemer	Crucible	Electric	Miscellaneous	Total. Gross tons
1902	112,404	255,475	367,879	12,548	4,955	.....	5,553	390,935
1903	134,879	265,469	400,348	18,099	5,409	.....	6,409	430,265
1904	98,919	203,915	302,834	16,051	4,308	.....	7,018	330,211
1905	206,159	320,381	526,540	22,103	5,733	.....	6,391	560,767
1906	313,548	406,343	719,891	32,601	10,343	.....	10,870	773,705
1907	366,476	380,049	746,525	33,273	10,233	.....	13,086	803,117
1908	155,005	156,772	311,777	20,559	8,271	.....	5,613	346,220
1909	306,005	295,035	601,040	33,814	12,683	306	8,399	656,242
1910	433,976	429,375	863,351	58,335	14,632	1,320	3,194	940,832
1911	266,626	304,565	571,191	57,101	14,030	1,878	2,427	646,627
1912	443,998	426,850	870,848	68,750	20,550	4,162	2,311	966,621
1913	460,161	450,055	910,216	80,506	17,571	9,207	3,244	1,020,744
1914	334,144	270.173	604,317	65,882	11,186	8,551	3,310	693,246
1915	333,103	402,229	735,332	92,476	14,756	23,064	1,196	866,824
1916	605,512	570,937	1,176,449	142,791	9,351	42,870	302	1,371,763

How Cores For Motor Car Castings Are Made

A Description of the Methods Employed by the Ferro Machine & Foundry Co.—Core Room Refinements Facilitate Large Production

AN HISTORIAN states: "Iron founding received an impetus in the latter part of the eighteenth century, such as it had never before experienced. The steam engine of Watt, coming into use at this time, developed the iron manufacturers at a wonderful rate, as by its means blast power was increased and all rude contrivances driven by horses and oxen were gradually abandoned in favor of the blowing engines driven by steam." Of equal, if not greater, importance in the development of the founder's art is the invention of the gas engine. The invention of these two types of engines with more than a century intervening, marks the beginnings of two great epochs in foundry practice. The advent of the modern gas engine has developed a special branch of foundry work which is closely akin to the machine shop in the accuracy of its work. The molder, coremaker and patternmaker have all been called upon to acquire increased skill.

Unusual Skill is Required

Intricacy of design and the thinness of section demanding innumerable cores present difficulties to the maker of automobile castings which not only demand skilled workmanship in all departments, but also require unusual ingenuity in laying-out the work and in the development of special molding machines. One core, that of the cylinder head for example, is made of more than 20 separate parts so designed that the thickness of the metal is only $\frac{1}{8}$ or $\frac{3}{16}$ inch. Such work necessitates machines which will make the cores with extreme accuracy and assembling devices and jigs, assuring the utmost precision in alignment and workmanship.

Developments in Patternmaking

Patternmaking, too, has undergone radical improvements. The refinement of this class of work does not permit the use of the old wood core boxes and patterns. The metal-working department of the patternmaking shop is an essential feature of a modern plant. Core boxes are made of metal and machined to the hundredth part of an inch. The patterns are all machined from special castings made from the original master patterns.

High-grade workmanship and means to secure expediency in production extend beyond the pattern shop and the core room to the foundry where the metal and the sand are prepared with extreme care using every precaution known to scientists to secure the best of results. The molds are made on automatic machines which give maximum production without sacrifice of accuracy. The sand is carefully selected and prepared to insure smooth castings free from blowholes and similar defects. The metal must come within the close restrictions of a rigid analysis and must be poured at a temperature which will preclude the possibility of cold-shuts and other ills that such castings are heir to.

One of the many foundries which have been successfully handling automobile engine work is that of the Ferro Machine & Foundry Co., Cleveland. The complete equipment of this plant and the large scale of production make it of unusual interest. One of the outstanding characteristics of the foundry work handled by the Ferro company is the great diversity of castings. The many different types include parts ranging in size from those for the smallest four-cylinder automobile, to the more complicated sizes, eights and twelves to the enormous heavy-duty engines designed for submarine chasers.

Practice in Pattern Shop

Forty patternmakers working in a large, light shop make the various patterns, core boxes and driers for the core room and foundry. A section of the shop, which is 40 x 140 feet, is shown in Fig. 1. Drawings received from the engineering department are laid out in the pattern shop for the master patterns and the cores. The master patterns are made from selected white pine of which

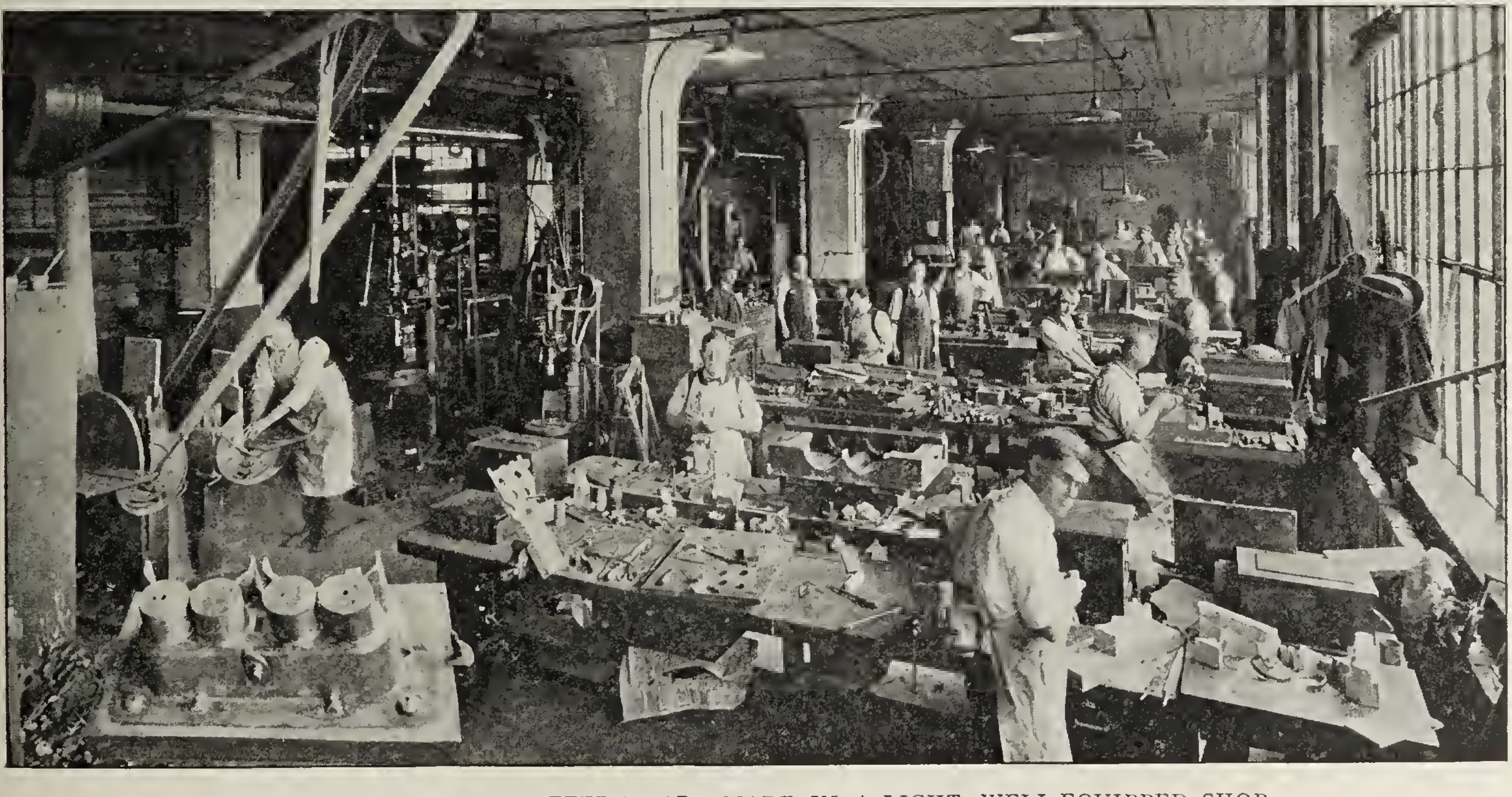

FIG. 1—THE MASTER PATTERNS ARE MADE IN A LIGHT, WELL-EQUIPPED SHOP

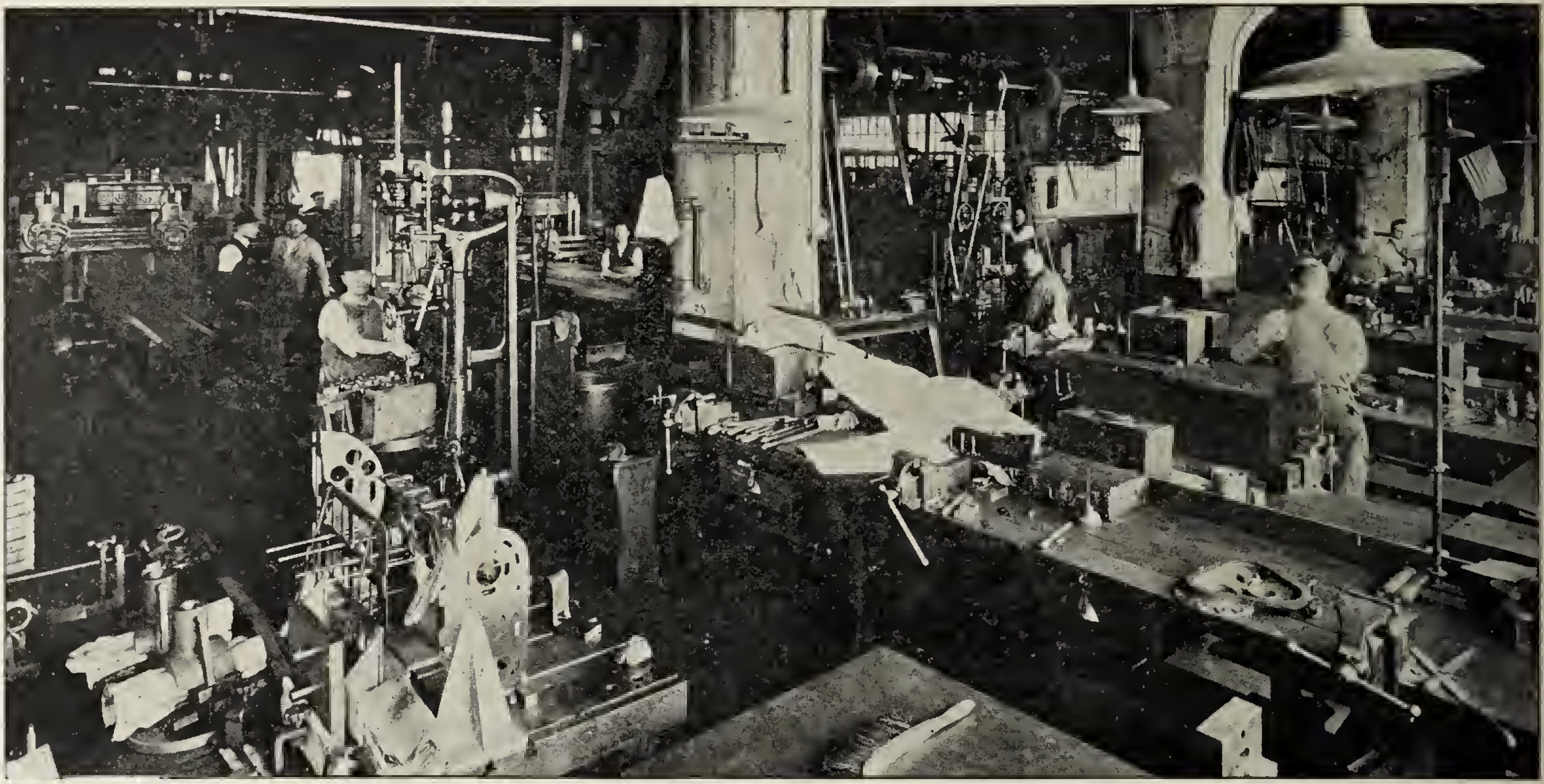

FIG. 2—TOOL ROOM WHERE THE METAL PATTERNS ARE MACHINED AND ASSEMBLED

a stock of standard sizes of 3000 to 4000 board feet is kept in storage. This plan allows the wood to thoroughly season and eliminates the danger of shortage of lumber. Special work, where warping is liable, is made of mahogany. In general, all patterns are built in sections to facilitate machining and assembling. After brass or aluminum castings for the metal pattern have been made, they are sent to a checker who lays out the machine work. All the patterns are machined in the company's tool room which is adjacent to the pattern shop. A corner of this room showing a few of the machine tools and part of the assembling benches is illustrated in Fig. 2. When the parts have been machined and cleaned they are assembled and sent again to the checker who approves them or returns them to the tool room for necessary changes. A striking illustration of the value of co-operation is afforded by a plan in effect in this shop. While the pattern is being made, the head patternmaker keeps in touch with the foremen of the core shop and foundry who go over the details and pass on such matters as gating, heading and proper design and arrangement of cores. No pattern is allowed to leave the shop until it has the approval of the heads of these departments. Driers are made for all complicated cores. The patterns for these usually are made of plaster of Paris. White metal or cast iron is used for the drier castings.

Both the metal pattern shop and the tool room are well equipped. Two band saws, one for metal and one for wood, a pony planer, jointer and a rip saw made by the Oliver Machinery Co., Grand Rapids, Mich., constitute the major portion of the equipment of the pattern shop. In addition to these tools, there are speed lathes, drill presses and a Gardner sander which carries two 29-inch wheels providing both sand-paper and carborundum surfaces. All of the

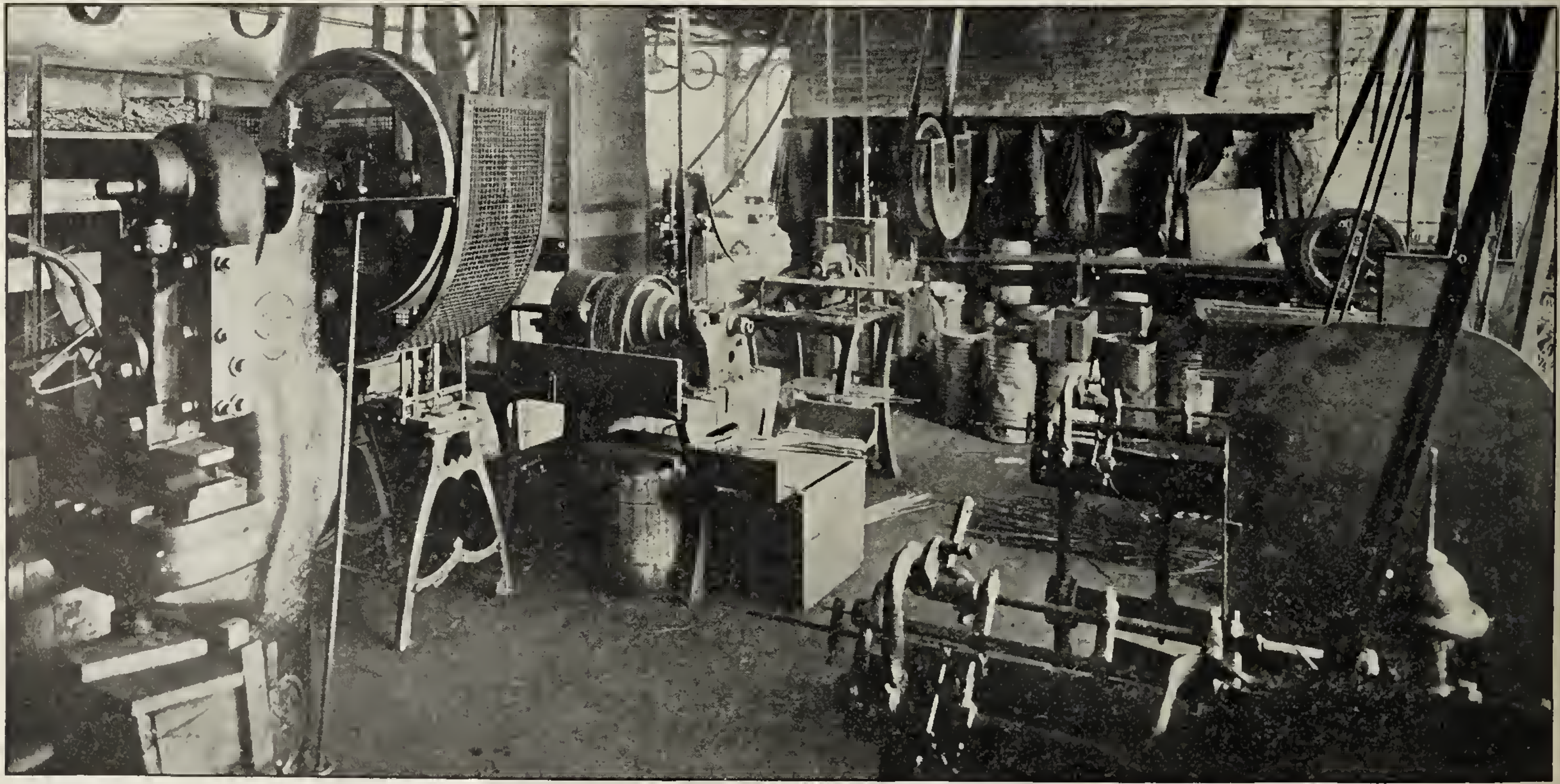

FIG. 3—COREMAKERS IN THE FERRO PLANT USE TWO TONS OF CORE WIRE A DAY—MACHINES IN THIS DEPARTMENT CUT AND BEND THE WIRE TO DESIRED SHAPE

wood-working machinery is equipped with suction pipes to carry away the dust. The tool room, which is 100 feet wide and 200 feet long, and employing 65 men, is equipped with planers capable of handling work 4 x 12 feet, boring mills which will carry work 4 feet in diameter and about 50 other machine tools. The tool crib which is located in the tool room, serves both departments. Numerous tungsten lamps in large reflectors give adequate illumination for night work.

Men working on patterns in either the wood shop or the tool room keep accurate account of the time they spend on each piece. A time card is supplied for each job on which is recorded the time at the start and finish of every period the men devote to it.

Every effort is made to facilitate the work in these shops. A night crew of six men is employed in the pattern shop to repair any equipment which may have failed during the day. Broken patterns and core boxes constitute a large portion of this night work. Large steel racks and numerous shelves provide adequate storage space for the patterns and core boxes. Each pattern is carefully indexed so that it may be located without delay and master patterns are retained until there is no liability for additional patterns for larger orders demanding an increased scale of production.

Specialty Work Brings Core Room Refinements

The greatest change wrought by the refinements introduced with the casting of cylinders for self-propelled vehicles is to be noticed in the core room. In foundries of two or three decades ago, one or two coremakers could turn out sufficient cores to keep several molders busy. The specialty foundries devoted to the automobile industry today frequently employ as many coremakers as molders. The complete core for a modern gas engine, when assembled in the mold, may be composed of as many as 50 separate parts. That the founder appreciates the accuracy and dexterity of a good coremaker is indicated somewhat by the wages being paid for this class of work. It is a poor workman who cannot earn at least $5 a day making cores for the modern, light weight, efficient gas engine. Special molding machines designed to produce cores with great accuracy in a minimum of time, aid the coremaker to make the most of his piecework scale of wages. The coremaker has at his disposal helpers who place his cores in the ovens and keep his stock of sand from running short. Outside of the labor necessary to make his cores, the only labor demanded of the coremaker is to place the finished core on a convenient rack in front of the drying oven where the cores are baked.

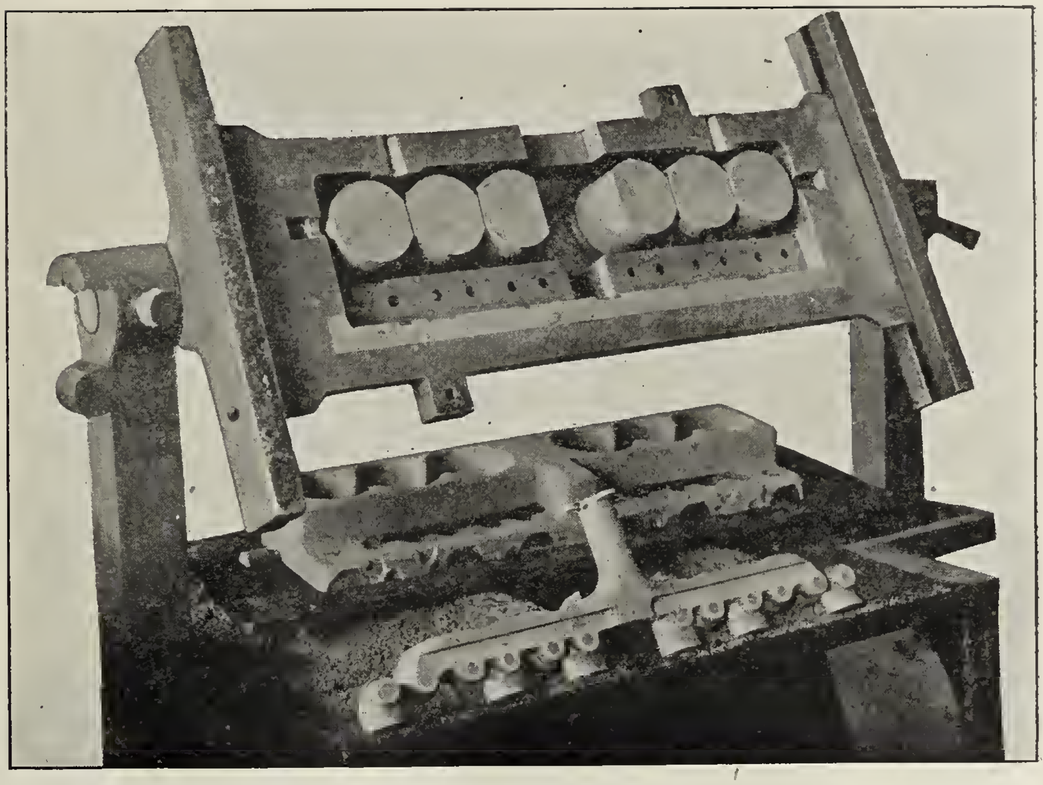

FIG. 4—COREMAKING MACHINE WHICH HAS ROLL-OVER AND JAR-RAM FEATURES

The core rooms of the Ferro Machine & Foundry Co. employ 150 coremakers and 40 laborers who use two car loads of sand a day. The sand is dumped from the cars on the company's siding into a special hopper which regulates the flow of sand to a traveling belt. This belt carries the sand about 1200 feet to the sand mixing machine which has a capacity of 600 quarts per batch. The mixing machine, which was made by the Standard Sand & Machine Co., Cleveland, is so arranged that one charge of sand may be prepared while another is being mixed. Eight batches may be prepared per hour. Three different grades of sand are used in the core rooms of the Ferro plant. The variation in closeness of the three grades is utilized to provide for different degrees of gasing. Michigan City and bank sands form the basis for the mixtures. Oil, made by the Werner S. Smith Co., Cleveland, is used in proportion of 1 to 65 as a binder. From the time the sand enters the railroad hopper until it reaches the coremaker, it is not touched by hand. The mixing pit is so arranged that the sand may pass directly to the mixing machine where the oil is added.

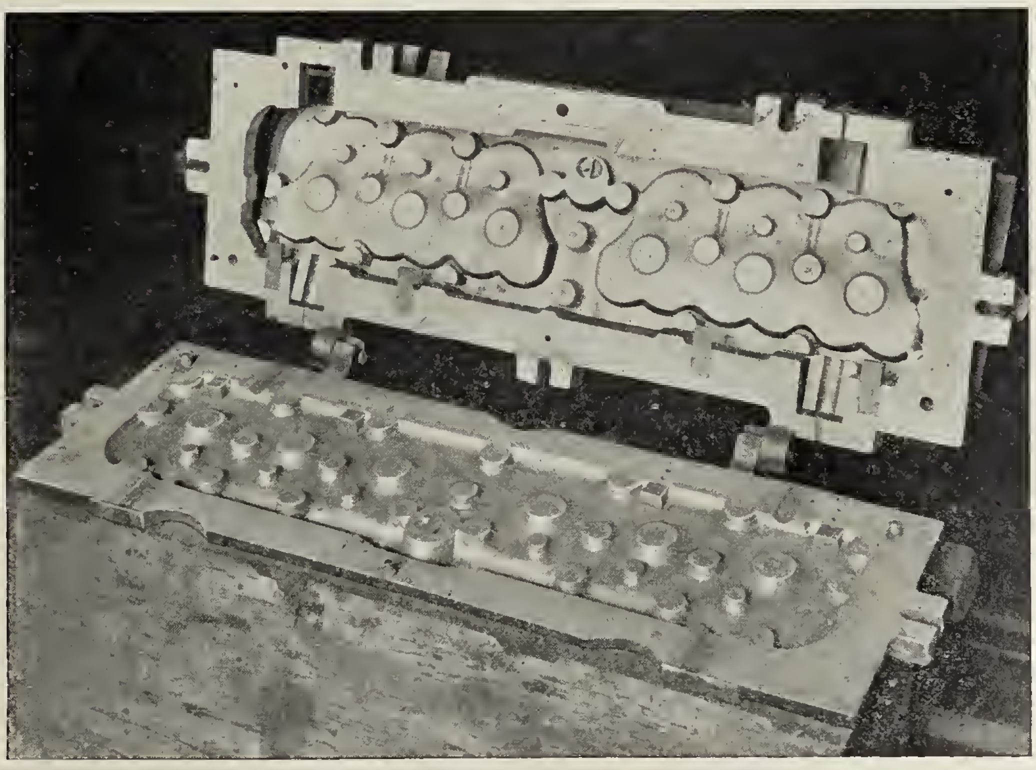

FIG. 5—IMPROVED CORE BOX FOR MAKING CYLINDER HEAD CORES—ITS CONSTRUCTION ELIMINATES THE LOOSE PLATES OF THE CUSTOMARY BOX

Passing from the machine, the sand is carried to the core room on the second floor by a bucket conveyor which dumps it into one of three storage bins depending upon the mixture. The discharge of the sand into these bins is regulated by a control handle near the mixing machine in the basement. Sand for the large core department in the basement is drawn through chutes from the bins on the second floor. Parting compound is used sparingly in the core boxes. They are blown out with compressed air and cleaned occasionally with kerosene. On cores having delicate structure lycopodium is used.

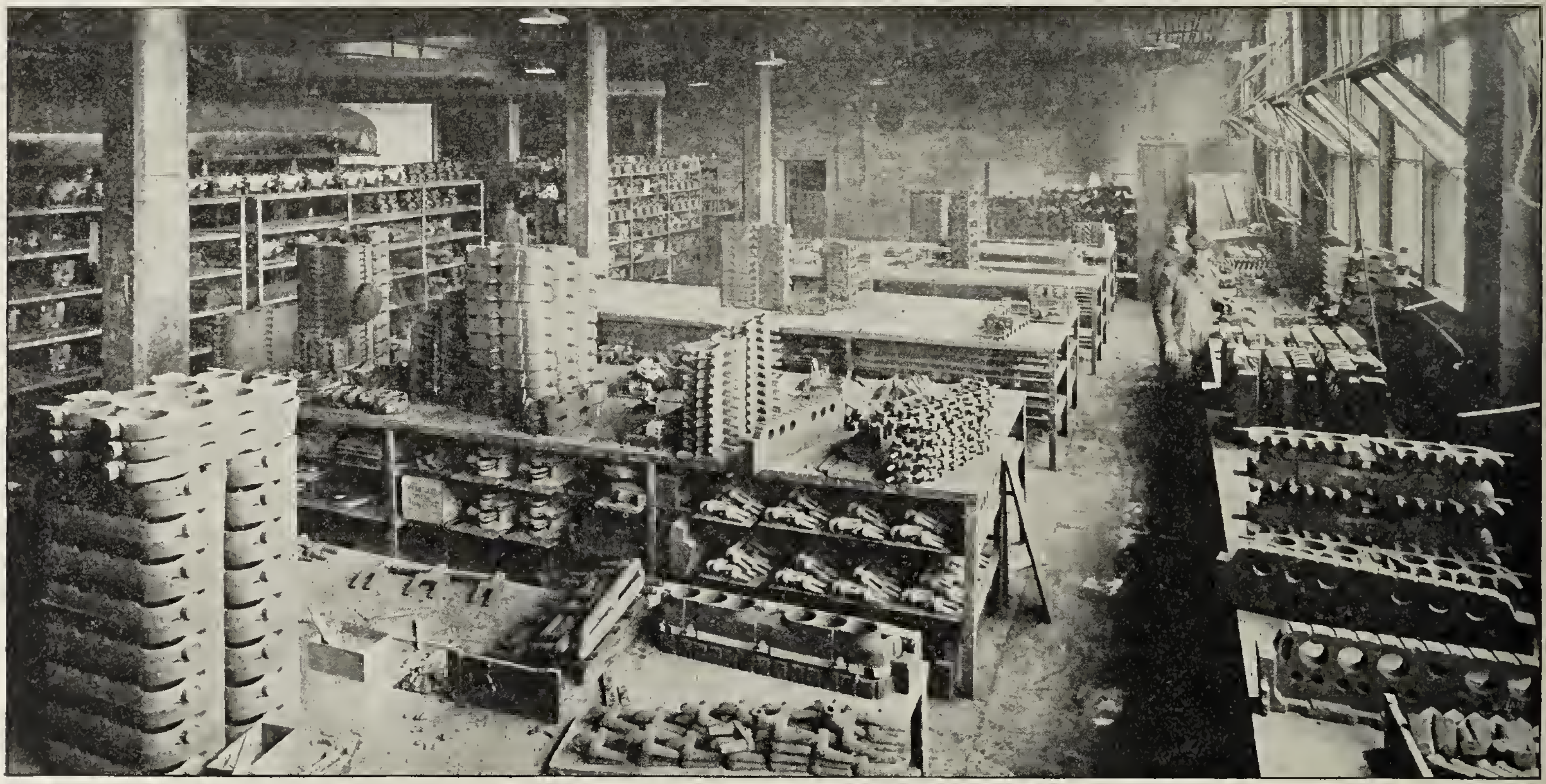

FIG. 6—ONE OF THE LARGE CORE-ASSEMBLING ROOMS WHERE THE CORES ARE FILED TO EXACT SHAPE IN JIGS

One of the unique machines in use in the core room, which was designed by J. T. Stoney, superintendent of the foundry, is shown in Fig. 4. It is actuated by compressed air and combines both air drawing and air ramming features. The illustration shows the core box rolled over in a position to be photographed after the core has been drawn. Nine or 10 inches straight vertical draw is possible with this equipment, and, where necessary, a draw of 13 inches may be obtained by tipping the core box as it is drawn and sliding the core away from the bench. The machine, shown in Fig. 4, is used to make the water jacket for a six-cylinder engine.

An interesting feature of the method of molding water jackets and other cores having circular sections is that they are split flatwise wherever possible, to eliminate the necessity of sweeping the cylindrical surfaces in the core box. This scheme makes necessary a slight departure from regular practice, in some instances, in locating the core prints, but this is more than compensated for in the time saved and by the elimination of machined, cylindrical driers to fill in the barrel sections of the jacket. This method assures great accuracy in the thickness of the walls of the water jacket.

One of the most complicated cores with which the coremaker has had to cope is that for the cylinder head. The thin metal section and the intricacy of design of the cylinder head have served to make the production of the core for this part of the engine, a task requiring infinite care. The type of core box illustrated in Fig. 5 is in general use in the core rooms of the Ferro company. It eliminates some of the difficulties experienced with previous methods which included the use of loose plates. In employing the customary style box with the separate plate which is put into place after the lower part of the box has been rammed with sand, it was found that trouble was experienced in removing the sand from between the bosses which provide the openings in the cylinder head for intake and exhaust valves, etc., and in properly locating the loose pieces. This was accomplished by probing between the surfaces of the two bosses after the plate had been placed in the sand. The improved box, however, is split through the center and hinged, as clearly indicated in the illustration. The upper part which replaces the loose pieces formerly driven into the sand, is so arranged that it may be withdrawn from the upper hinged half. In making the core for the cylinder head with this box, the two halves are separated at the open hinge and rammed individually. After this operation, the two halves are placed together and locked by thumb screws at each end of the box. These thumb screws serve both to hold the compression plate in place while the upper half is being rammed and to lock the box when the two parts are assembled. The compression plate is then withdrawn from the box leaving the two hinged frames still locked. Driers are then dropped into position and a steel plate put on the box. It is then rolled-over and the frames are withdrawn from the core. The time of making cylinder-head cores with this box is said to be about one-third that required for molding with the loose plate box. Reinforced steel core plates, made by the Wadsworth Core Machine & Equipment Co., Akron, O., are used in both core rooms.

A gage of the number of cores made in one day is the amount of core wire used. The wire room, a portion of which is shown in Fig. 3, handles approximately 2 tons of new and old wire a day. About 80 per cent of the core wire is reclaimed. The equipment of this department includes bending, pressing and cutting machines. Work that cannot be handled by machines is bent to form in bench jigs. The various shapes and sizes of core wires are stored in steel racks where they are readily accessible for the coremakers. All the chaplets are cut and bent in this department. Every means is taken to prepare the wire in such form that it will save the coremaker the maximum amount of time.

All cores, with the exception of crankcase and similar large cores, including water jacket, port and pipe cores are made on the second floor where they are placed by the coremakers on racks

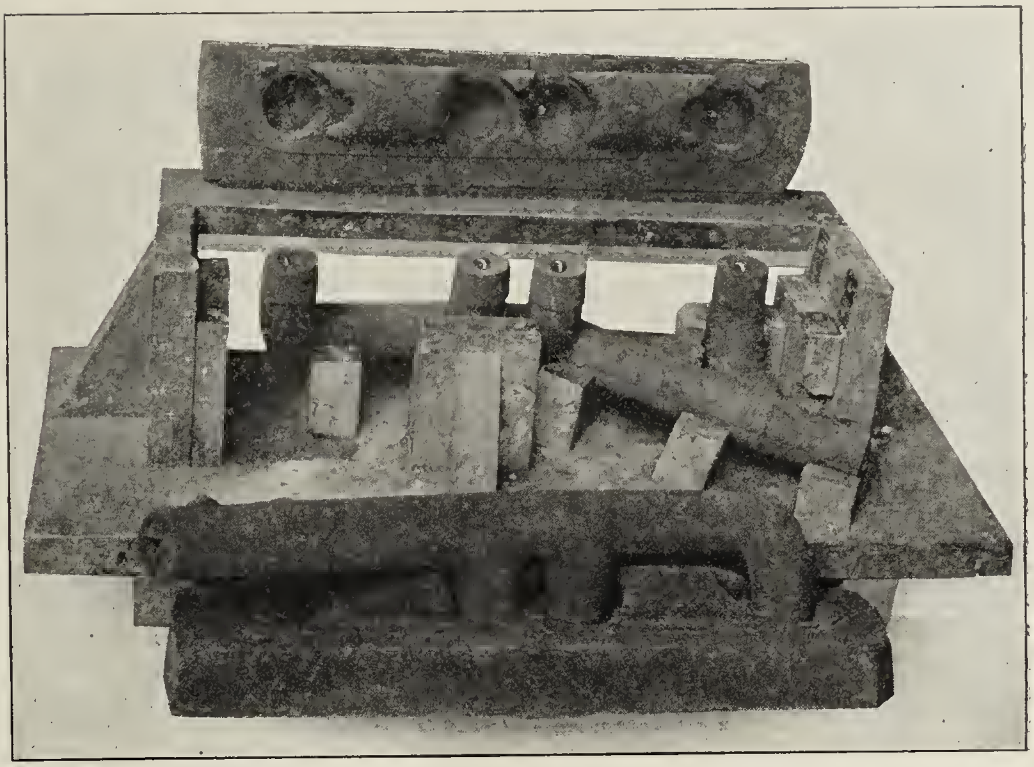

FIG. 7—UNIQUE METHOD OF LEADING CORES SECURES THE PARTS FIRMLY TOGETHER AND ELIMINATES THE USE OF CHAPLETS IN MANY PLACES

near the ovens. The venting of these cores is accomplished entirely without the use of coke. Cores of small cross-section depend upon the porosity of the sand. Larger cores are vented by inserting ½-inch brass tubes which remove a portion of the sand when they are withdrawn, thus providing egress for the gases. This operation is similar to sprue cutting on a bench molding job. The cores are baked in three coke-fired ovens at a temperature of 400 degrees Fahr. The temperatures are recorded by Bristol pyrometers. The duration of baking varies, of course, with the size of the core. Core driers are universally used to prevent distortion during baking, thus holding the cores to correct form.

After baking, the cores are placed on trucks and carried to the assembling department on the first floor. Stock racks are arranged there for storing cores awaiting to be assembled. A portion of this department, showing some of the storage racks and drying ovens is illustrated in Fig. 6. Before being assembled and pasted, all the cores are placed in jigs and filed to exact size. After drying the paste, which is a mixture of dextrine and flour, the cores are again stored in readiness for the demands of the foundry. The ovens in this room are located directly below those in the coremaking department on the second floor and are heated by the same fires. One of the most unique features of the core assembly department is the method of leading cores to hold the different sections in the precise position desired. This method is not only used because of its inherent accuracy, but because it serves to eliminate the use of chaplets in many places where they have been the cause of difficulty. Fig. 7 shows the jig with a core ready to lead and a completely leaded and assembled core. A close study of this illustration will reveal the manner in which the leading is accomplished. A loop of wire is embedded in the contact surface of one core; this projects into a hole in the corresponding contact surface of the second core. By pouring molten lead into the hole and allowing it to flow under the loop of wire and harden, the two cores become fastened firmly together. Because the cores are fastened securely together, they resist the pressure of the molten metal and the danger of leaks in the casting such as occur when chaplets do not fuse is entirely eliminated.

The larger cores are made in the basement of the foundry building. To a large extent, the same general plan is followed there as in the small core department, automatic machines being employed wherever possible. The system of handling the heavy cores, however, is especially interesting. As the cores are made they are placed on steel racks similar to the one shown in Fig. 8. On the ceiling above each of the six divisions of this department are arranged six crane arms pivoted in the center of a circular track. The racks loaded with cores are picked up by one of these cranes and swung around to a crane track which runs along the ceiling in front of the battery of six gas-fired core ovens. A junction of a circular track with the straight track may be seen at the right of the illustration. The racks are dropped to the floor and are picked up by an electric traveling carriage operating on the track in front of the ovens. When the traveling crane or carriage has carried the rack to the oven, a detachable lifting mechanism is transferred from an auxiliary track on the crane carriage to tracks running into the oven. After lowering the rack to its place in the oven, the lifting mechanism is returned to the crane carriage ready for further duty. The track running in front of the ovens makes a complete circuit so that it may be loaded from one side and unloaded on the other. The large cores are allowed to remain in the oven for six or seven hours. Large vent pipes extending to the roof of the building serve to exhaust the

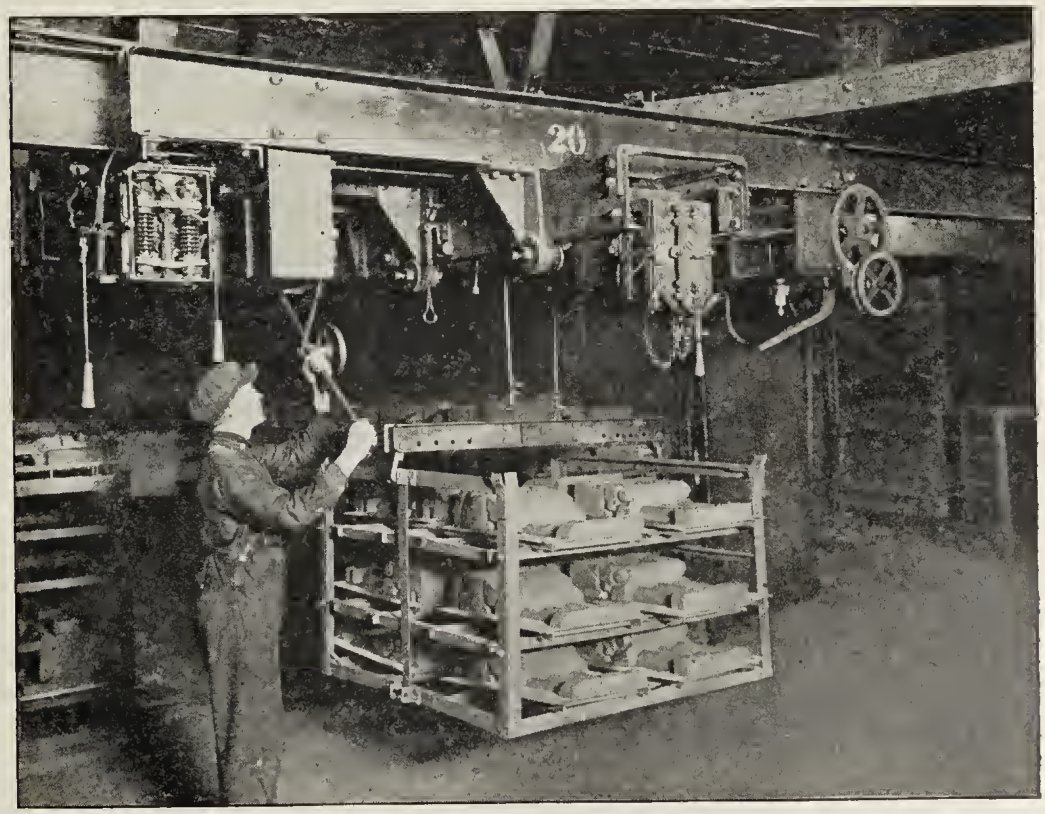

FIG. 8—HOW THE LARGE CORES ARE CARRIED TO THE OVENS—CRANE ARRANGEMENT SAVES LARGE AMOUNT OF LABOR

burnt gases and existing moisture. Where a smooth surface is desired on the cores, they are sprayed while green with a mixture of talc and water. No binder is used, the binder in the core sand being sufficient. Small cores are dipped and air-dried, drying in about 1½ hours. This mixture is also used as a paste to daub the joints of cores which have been cemented together.

The plans on which the core rooms are operated assure a large supply of cores available at all times for use in the foundry and preclude any possibility of shortage. In fact, the core department endeavors to work three days in advance of the foundry. These days may be divided into three periods representing cores being made, cores being assembled and cores in storage. The great variety and volume of work carried on in the foundry of the Ferro Machine & Foundry Co. presents a number of unusual problems which are of equal interest to those of the pattern shop and core rooms. A description of the special equipment and the methods employed in this foundry will be published in an early issue of THE FOUNDRY.

Book Reviews

The Founder's Manual: by David W. Payne, editor of *Steam;* limp leather; 680 pages, 5 x 7 inches; 245 illustrations. Published by the D. Van Nostrand Co., New York, and furnished by THE FOUNDRY for $4 net.

Information of interest to foundrymen can be found in a large number of publications devoted to casting problems. Those in search of data, however, not always have been able to secure the desired facts without going to an undue amount of trouble in determining the proper source of information. *The Founder's Manual,* by David W. Payne, overcomes this difficulty by combining in one volume a vast amount of material for the solution of problems which are continually presented in the foundry. Many articles and tables published in THE FOUNDRY are reproduced in full.

The first three chapters are devoted to elementary mathematics, tables of weights and measures, and natural sines and tangents. In Chapter IV, the weights, dimensions, strengths, etc., of various materials are tabulated. The following chapter is devoted to a brief statement of the principles of mechanics. Chapters IX to XIII contain some unusually valuable information regarding the chemical constituents of cast iron, the theory of mixing irons, and data regarding steel scrap in mixtures of cast iron, the use of test bars in determining the physical properties of cast iron, and the value of chemical analyses. Chapter XIV is devoted to standard specifications for cast iron wheels, locomotive cylinders, and cast iron pipe. Mechanical analysis is the subject of Chapter XV, which includes a description of the shrinkage chart and an explanation of Keep's shrink table. Chapter XVI is devoted to malleable cast iron and traces the development of the malleable industry from the time of Reaumur's discovery. The next chapter is devoted to the manufacture of steel castings. This is followed by a wealth of information on foundry fuels, a description of various types of cupolas, molding sand, including mention of bonding power, permeability and porosity, refractoriness, durability and texture; the core room and its equipment; molding room apparatus; molding machines, including jigs, flasks; and a discussion on molding.

Other chapters are devoted to discussions on continuous melting, the determination of the weights of castings, including methods of finding the weights of patterns, pattern lumber, and formulas for obtaining the required weight on copes; gas, water, lighting, heating and ventilating. Chapter XXVII covers the subject of foundry cost accounting in a thorough manner. Foundry requisitions, pattern cards, heat book, and various other records are reproduced. A pig iron directory is one of the features of *The Founder's Manual.* Coke, anthracite and charcoal irons are classified separately, the trade name of the iron is given and in addition the number of furnaces, the locations of the stacks, the name of the operators, type of blasts used and the kinds of ores employed are included.

Organization in Accident Prevention; by Sidney Whitmore Ashe; cloth; 130 pages, 6 x 9 inches; published by the McGraw-Hill Book Co. and furnished by THE FOUNDRY, for $1.50 net.

Accident prevention is a problem which is occupying a constantly growing place in modern industrial life. Interest in the work prevails for two reasons—a humanitarian effort to prevent suffering, and the natural desire of the business man to keep his plant running at as near 100 per cent efficiency as possible. He cannot accomplish this if his working force is constantly shorthanded because of preventable accidents.

To make accident prevention truly effective the employer must study organization and must see to it that his foremen and their assistants are prepared to work with him. In other words, he must have co-operation. How this can be brought about most effectively is shown by the author of *Organization in Accident Prevention.* "Fellowship, system, education and discipline are the four necessary elements in safety and health work." The co-operation of the employe, engendered by a feeling of fellowship, is the greatest help that the employer can have in safety work. Also, a definite system of work with definite men in charge is desirable in order to get satisfactory results. This system when perfected, will contain a complete plan for the education of the employe in the methods of preventing accidents, and will also provide disciplinary measures which may be necessary in some cases to force the employe to take the prescribed precautions.

Chapter II discusses specific accidents which may be reduced by educational means. The author describes the best methods of avoiding these accidents and the most effective methods of treating them if they do occur. Another chapter is devoted to the consideration of the subject of medical and physical examination of employes with special reference to tuberculosis and hernia. The necessity of emergency treatment in the plant itself is discussed and the various emergency methods described. The emergency hospital at a plant plays an important role at times.

The vital necessity for accident prevention work is strikingly shown by the statistics given in the chapter entitled "Records, Analysis, Ratio Curves". Many interesting illustrations are shown.

Calcium and Its Uses

Calcium in appearance somewhat resembles sodium, but unlike the latter it is not soft, but hard and tough and difficult to cut with a hacksaw or a hammer and chisel. Calcium readily alloys with copper and may be added to the molten copper like any other metal, provided the calcium is first warmed and is not too suddenly pushed under the surface of the copper. The union of the calcium with the copper is attended by the liberation of great heat, much more than in the case of the addition of aluminum to copper. The addition of 10 per cent calcium to copper increases the temperature of the latter to approximately 1400 degrees Cent. Copper, with 5 per cent calcium, is hard and brittle, and can be broken with a hammer; with 10 per cent calcium the alloy still retains its hardness and brittleness, but becomes filled with gas cavities. With 50 per cent calcium, the alloy becomes silvery with a yellowish cast, and consists of long crystals easily detached as slivers. The alloy is soft and exceedingly active chemically. It will combine with chlorine in common salt and liberates the sodium; it combines with the oxygen in alumina and liberates aluminum, and with sulphur it combines with explosive violence. Calcium copper smells strongly of acetylene gas. It will not deoxidize copper, to make solid copper castings, with any degree of uniformity, but if a sound casting is obtained the electrical conductivity is very good.

Increasing the Output of the Plating Room

How the Efficiency of Workmen and Equipment Can Be Increased—Losses of Electrical Energy Retard Production

By E P Later

EVERY plater occasionally is confronted with the necessity of handling a largely increased volume of work, resulting either from the normal growth of the firm or from improved business conditions, and then the question of how to increase the capacity of his department with the least expenditure of money presents itself for solution. Two ways of increasing the output immediately are considered, namely, by adding new equipment, or by raising the efficiency of the workmen and equipment available. The latter course, naturally, is always to be preferred, inasmuch as new tanks and machinery are costly and, in addition to this, the increased floor space used, larger amount of power required, and so on, are expensive items which eat deeply into profits.

The prices of almost everything have advanced to such heights recently, and the delay in obtaining supplies has been so great, that additions to the plant can be made only with much difficulty and expense. This is particularly true of generators and electrical apparatus in general, the scarcity and high price of copper and brass, as well as other conditions serving to make such appliances hard to get at any price.

Investigate Present Equipment

For various reasons, therefore, every effort should be made, before adding new equipment to take care care of an increased amount of work, to see that the present outfit is really working at its full capacity. Very often surprising economies and improvements can be made by a thorough overhauling of everything, with the view of correcting whatever unfavorable conditions come to light and making such alterations as experience or inspiration may suggest.

To be of the greatest value such an investigation should be as complete as possible and a few suggestions, serving merely to indicate some of the more important points to be noted, may not be out of place. For instance, one source of wasted motion and effort on the part of the workmen is faulty arrangement of the various cleaning and plating tanks and other equipment, and a short study of this feature often will show how an improvement can be made easily and cheaply.

The formulas for the various plating solutions also should be examined to see if they are in accordance with the latest information and best practice; with some of the newer formulas it is possible to use much higher current densities than formerly, and inasmuch as this means turning the work out in a correspondingly shorter time, thereby increasing the output of the plant, it is apparent that an investigation of this kind may bring large returns.

Losses Due to Dilution

Maintaining the solutions of the correct composition also is a factor too important to be overlooked. The composition is certain to vary more or less with use, due to loss of solution, dilution, and impoverishing from imperfect corrosion of the anodes, and unless this is corrected, losses of one kind and another will surely be incurred.

Lack of proper care and attention to the generator, poorly made or corroded connections, dirty contacts in the rheostats and too infrequent cleaning of anode and cathode rods may, and often do cause large losses of electrical energy, thereby lowering the general efficiency of the plant; instead of doing useful work in the plating tanks or electric cleaners the current is wasted in overcoming all of this unnecessary resistance. Again, faulty insulation sometimes alows current to leak from anode to cathode without passing through the plating tanks; or the mains and leads may be too small to carry the current used, in which case they will become hot and thus further dissipate electricity in the form of heat.

After conditions of this kind have been removed, or have been shown not to exist, it may be found that the capacity of the plating equipment is still somewhat below requirements and in this case the use of a storage battery may be a convenient way out of the difficulty; such a procedure has several points in its favor.

First, it may permit of the installation of an additional tank or so without making it necessary to put in a larger generator at the same time. This may be more clearly understood when it is remembered that the load in the average plating room is subject to rather large variations. Often it is not possible, for one reason or another, to operate all of the tanks at once, or the parts which are being plated may be of such shape that a comparatively low current is used. On the other hand, the generator must be large enough to operate all of the tanks and probably an electric cleaner, which alone will usually take several hundred amperes, at one time. The result in either case is unsatisfactory in some ways. A dynamo running below its normal capacity does not operate at its maximum efficiency and if it is too heavily overloaded it will soon heat badly and may burn out. In short, a storage battery often can be utilized to advantage to keep a generator running at somewhere near its full rating when the plating load is light, by storing-up the excess and supplying current at other times to help out the dynamo during overloads. In this way the actual capacity of the power plant not only can be increased considerably, but a much wider range of voltage can be obtained, when desired, than otherwise would be the case. This point will be taken up later.

Advantages of Storage Battery

One of the greatest advantages, at least in certain instances, and one which alone would perhaps be sufficient to justify the use of such a system, is the opportunity thus afforded to work the solutions at times when they are ordinarily standing idle. At noon, for example, the power usually is shut-off for an hour, and counting the time lost in taking the work out and putting it back, considerably more than one hour easily may be lost. In a working day of only eight or nine hours this is a rather serious matter. If a storage battery is available the output of the tanks can be increased by at least one full load a day, for during the noon hour the battery can be switched on, using a sufficiently lower current density than usual if necessary to compensate for the increased length of time that the parts are plated, and deposition may be continued without interruption.

In the same way certain classes of work requiring a heavy deposit can be plated over night without difficulty, always bearing in mind, of course, the necessity of cutting down the current to the proper strength in order to obtain a deposit of the desired weight.

A little reflection will show that the use of an auxiliary storage battery presents several advantages and possibilities, but before going into some of these in more detail, it may be helpful to review a few facts concerning the construction and operation of this piece of apparatus.

The type of cell most widely used for work of this kind consists of specially-prepared lead plates immersed in a dilute solution of sulphuric acid, contained in jars made of glass or other suitable material. One of these plates is coated with a compound known as lead peroxide and forms the positive plate or pole; the other is covered with sponge lead—a certain form of metallic lead—and constitutes the negative plate. They can be distinguished, when the cell is in good condition, by the fact that the positive plate is of a distinct brown color, while the negative plate is gray; incidentally, the positive plate is quite hard, while the negative is much softer. These plates usually are thin and it is thus possible to place several of each polarity in the same container, connecting all of the positive plates together at one terminal and all of the negative plates at the other terminal, the two sets of plates being so placed within the container that each positive plate has a negative plate next to and facing it on both sides. Inasmuch as adjoining plates are all of opposite polarity it is necessary to keep them completely separated and well-insulated from each other, or short-circuiting of the cell will occur. Free circulation of the electrolyte must not be interfered with, however, so glass rods, or perforated rubber or composition strips are employed to keep the plates separated.

How Electricity is Generated

When a current of electricity is passed through an arrangement of this kind, certain chemical changes are brought about by the action of the current, the latter thus expending its energy in this way and putting the battery into the condition known as charged. When the battery is disconnected from the charging current it will be found that it is capable of giving out a current of its own, by reason of the fact that certain other chemical reactions the opposite of those which took place when the battery was being charged, now occur, in consequence of which electrical energy is set free and may be utilized. More specifically, the change occasioned by discharging, giving out electrical energy, is the gradual formation of lead sulphate on both plates. The positive plate at the end of the discharge is coated with a mixture of lead peroxide and lead sulphate, while the negative plate is covered with lead and lead sulphate. The passage of current through the discharged cell then causes the disappearance of the lead sulphate, with the formation of lead peroxide on one plate and lead sponge on the other; so this alternate charging and discharging may be kept up for a long time if certain precautions are carefully observed.

The lead sulphate which is formed during the discharge of the cell is a white substance having a high resistance and volume greater than that of either the lead or the lead peroxide from which it is formed. It is obviously necessary, therefore, to see that only a limited amount of it is produced, otherwise the plates will be damaged through the expansion and cracking off of the coating material. Partly for this reason a cell never should be completely discharged, but be re-charged or taken out of the circuit when the voltage drops to a certain point.

How the Cell is Damaged

Charging or discharging at too rapid a rate are also capable of doing a good deal of damage to a cell. Lead peroxide occupies a larger volume than the lead from which it is formed; so the volume of the active or coating material on the positive plate undergoes considerable change. It increases when the cell is being charged and decreases when the cell is discharged; therefore, if this expansion or contraction takes place too rapidly, from excessively high rates of charge or discharge, cracking and peeling of the coating will take place. In the same way, the tendency toward buckling or twisting of the plate, which may become a very serious matter, also is increased by carelessness in this respect.

Another source of trouble is the introduction of other metals into the electrolyte, the dilute sulphuric acid in which the plates are immersed. Unless proper precautions are taken this is particularly liable to happen around a plating room, from the splashing of plating solutions onto the cells, and results in very rapid deterioration. Sulphuric acid sometimes contains certain impurities which are detrimental, and it is essential, when it becomes necessary to replenish the electrolyte, that only distilled water and the purest acid are employed for plating room purposes. Finally, a storage battery should not be allowed to stand for too long a time after discharging, otherwise the formation of an excessive amount of lead sulphate on the plates takes place and the battery is said to be sulphated, a condition which is shown by the presence of white patches on the surfaces of the plates. It may be serious enough to ruin the cells for further use and make it necessary to replace the damaged plates. In cases where the sulphation is less severe, however, it may be remedied by overcharging the cells for some time. In order to prevent trouble of this sort, a battery should not be allowed to stand discharged for more than 24 hours.

The voltage of a charged cell may be as high as 2.4, but after it has been working a short time this drops to about two volts and remains fairly constant at this value for some time. Somewhere near the point where the cell is considered to be discharged the voltage begins to drop rapidly and when it falls to 1.8 to 1.7 volts, the cell must be re-charged before further use.

The capacity of the cell, or the amount of current which can be obtained from it, depends largely on the construction and is ordinarily expressed in ampere-hours; one ampere-hour represents a current of one ampere flowing for one hour, therefore the capacity of a cell or battery on discharge would be found or expressed by multiplying the number of amperes flowing by the time in hours. However, the capacity is not entirely a definite and fixed quantity, but varies with the rate of discharge and the temperature of the cell, decreasing with the former and increasing with the latter, at least up to a certain point. In order to have a definite basis for the comparison of cells, 70 degrees Fahr. has been settled upon as the standard temperature and the rate of discharge fixed at eight hours; that is, the eight-hour rate is the flow of current which a cell can maintain continuously for eight hours without the voltage dropping below the minimum allowable. According to this, a battery which can deliver 9 amperes continuously for eight hours would be rated as a 72 ampere-hour battery.

Limit of Discharge Rate

Of course, it is possible to employ such high rates of current flow that the battery would be discharged in a very short time, although the danger of such a procedure has been shown previously, or the current flowing may be made low enough for the battery to keep it up for a very long period. As a general proposition, it usually is not advisable to let the discharge rate exceed four or five times the normal eight-hour rate, although in certain cases, where a short period of heavy discharge is followed at once by charging, this may be done without harm.

The charging rate also varies; too low a rate is injurious, therefore, the charging current should not, as a rule, be less than about one-fourth that of the normal eight-hour rate, while it will be found that if it is greater than the two-hour rate there will be excessive gasing and the cell will become hot.

The Charging Rate

The capacity and number of cells to be employed will depend on the amount of current which will be required to relieve an overloaded generator at certain periods, or to keep some of the plating tanks going at times when the dynamo is not running, and ordinarily will be calculated on this basis. Suppliers of storage batteries always are glad to co-operate with customers to give whatever help or information may be needed and trouble may be saved by taking advantage of this opportunity to secure the benefits of their greater knowledge and experience.

In connecting-up the battery, the installer likewise will have to be guided by conditions. One convenient and well-known system is to have the battery running in what is known as parallel with the dynamo. In this way it will be charged when the latter is not working at its full capacity and then when heavier demands are imposed, the battery will begin to discharge and thus take care of the excess load. The exact manner of connecting the cells, at least partly, will depend on the voltage of the dynamo, for when a storage cell is being charged the voltage may reach 2.4 toward the end, which means that the charging current must be a little higher than this; consequently, a 6-volt current will charge two cells connected in series, while three cells in series will require a current of about 8 volts. In discharging, however, each cell may be considered to give 2 volts or less; when near the end of the run the voltage drops below this; therefore, three cells will be required to produce 6 volts.

For charging, it obviously is necessary to connect the cells in series in groups of two or three, depending on the voltage of the charging current, with the various groups in parallel, while on discharge it will probably be desirable to add one or two cells in series to each group, thus reducing the number of groups. For example, a battery of 12 cells could be charged in four groups of three cells and discharged as three groups of four cells, by a suitable arrangement of the wiring.

If desired, a 2-volt circuit, which is sometimes very useful, by taking current directly from one cell, or from as many cells connected in parallel as may be needed to give the desired capacity; a 4-volt circuit could be obtained by connecting two cells in series, providing more capacity if need be by adding in parallel one or more such sets or groups. Remembering that when cells are connected in series each cell added increases the line voltage by approximately 2, it is seen that a wide range of voltage can be had provided, of course, that a reasonable number of cells is available; thus, a 12-cell battery will give a maximum of about 24 volts. On the other hand, when cells are connected in parallel the voltage obtained is the same as that of a single cell, while the amperage or current obtainable is the combined amperage of all of the cells; by the judicious use of series and parallel combinations of cells, therefore, a circuit of any voltage and capacity within the limits of the battery can be obtained; when designing the switchboard this fact should be borne in mind and an effort made to secure as much flexibility in the operation of the system as possible, or warranted by the conditions or requirements of the case.

Testing the Hardness of Metals in Service

To ascertain the hardness of metals under conditions of service, a machine is being built by the Palo Co., 90-94 Maiden Lane, New York City. This instrument consists of a plummet, weighing one-tenth of a pound avoirdupois, which falls one foot to the surface of the material whose hardness is to be measured. This plummet has a conical, replaceable, chill-tempered, 60-degree steel point of which several are furnished with each instrument. To the upper end of this plummet is tied a very thin silk thread which passes over a funnel-shaped piece, having slotted holes with burnished edges so that the silk passes through them with practically no friction loss. The funnel turns with a slight friction in the end of the jointed supporting brass tube. The silk thread is attached to a small, burnished ring at its lower end, the ring in turn being caught in a small trigger which can be released by a thumb-screw without jarring the instrument. The silk thread so supports the plummet that it is directly over the aperture in the base of the instrument. The base is supported at three points, two of which are controlled by a leveling screw. Small cross levels indicate the verticality of the supporting rod.

In operation, the instrument is set on the surface of the material so that the aperture in its base is concentric with the spot to be tested. The plummet is supported by the silk thread and the funnel support is gently turned until the distance from the conical point to the surface of the material to be tested is exactly one foot. When the plummet is at rest, the trigger is released by a thumb-screw, the plummet falls and makes a uniform circular indentation in the material tested. The object in releasing the plummet from the bottom of the apparatus is to avoid any disturbance in its upper support. A portable microscope then is employed to measure the diameter of the impression made by the falling plummet point. The microscope is so designed that it has sufficient illumination and magnifying power to measure easily, the diameter of the impression made, with an eye-piece micrometer.

Increased Graphite Production

H. G. Ferguson, of the United States Geological Survey, department of the interior, estimates that the production of flake graphite for 1916 was about 11,500,000 pounds, as compared with 7,074,370 pounds in 1915 and 5,220,539 pounds in 1914. Alabama furnished about 5,500,000 pounds, and the remainder came from the mines in California, Montana, New York and Pennsylvania. In all, 16 companies produced flake graphite. The imports of flake graphite, chiefly from Ceylon and Madagascar, far exceeded the domestic production. Owing chiefly to the immense demand for crucibles for use in making munitions, the better grades of flake graphite now command more than double the price at which they sold before the war.

Most of the amorphous graphite used in this country is imported from Mexico and Chosen, Korea, but a total of 2562 tons was obtained from mines in Michigan, Nevada, North Carolina and Rhode Island. Amorphous graphite is not suitable for use in the manufacture of crucibles but can be used for making lubricants, pencils, paints and foundry facings.

Made Sand Blast Machines

On page 231 of the June issue of The Foundry it was stated that certain cleaning room equipment, including four horizontal table sand-blast machines in the foundry of the Buick Motor Co. were built by the W. W. Sly Mfg. Co., Cleveland. The four horizontal table sand-blast machines were manufactured by the American Foundry Equipment Co., New York, the other equipment mentioned having been furnished by the W. W. Sly company, as stated.

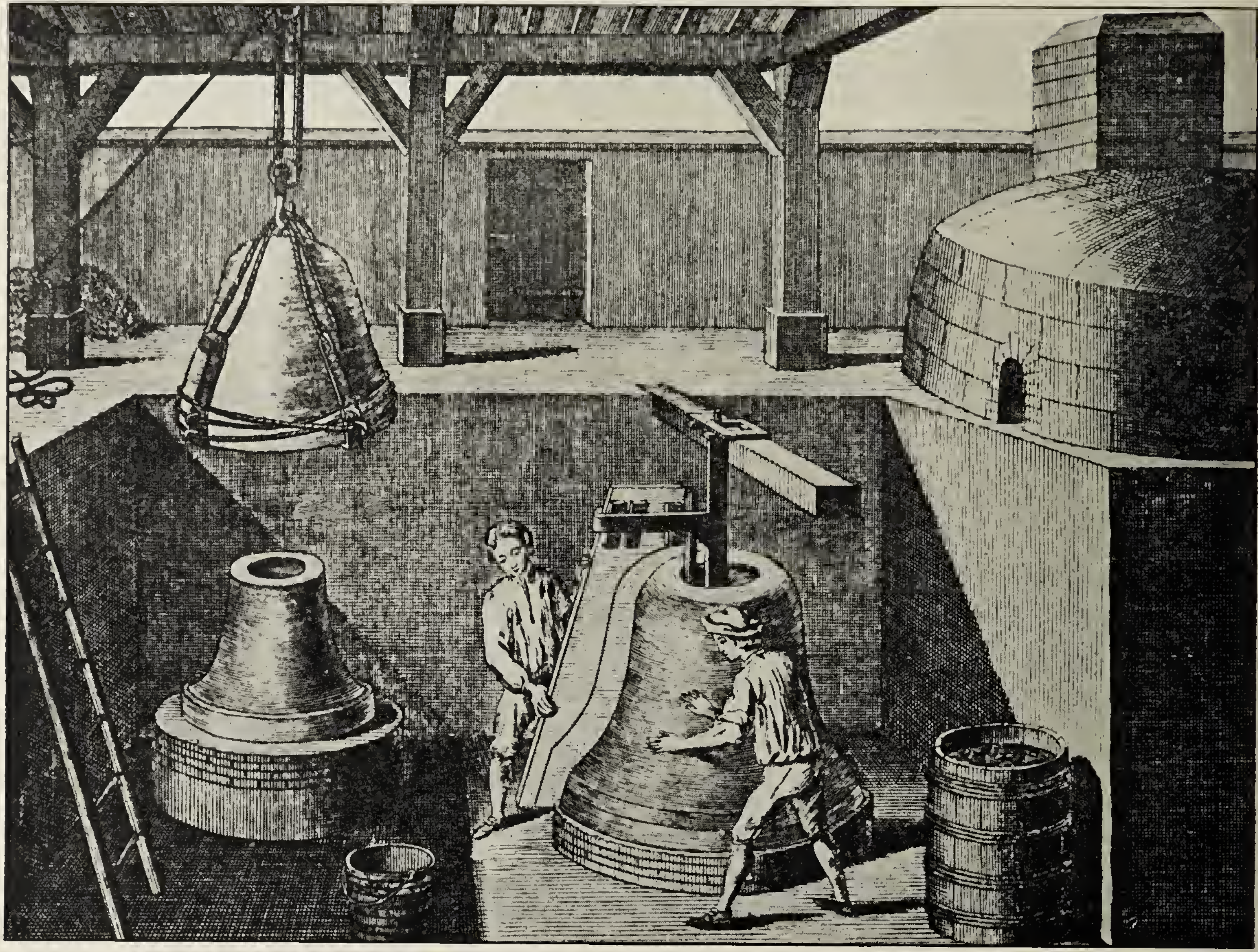

FIG. 15—CASTING BRONZE BELL IN CLAY, 1775

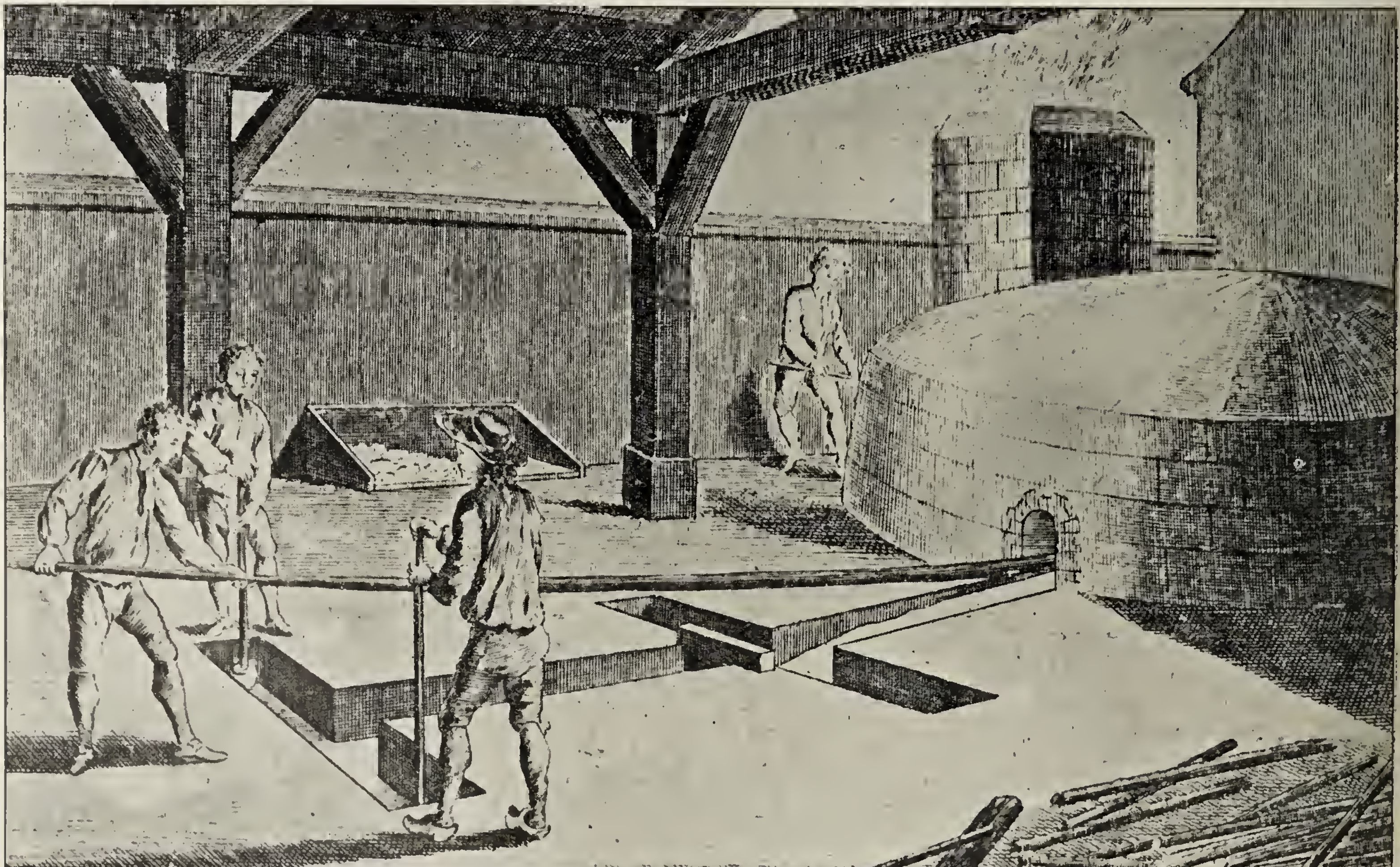

FIG. 16—TYPE OF FURNACE USED IN BELL FOUNDRY, 1775

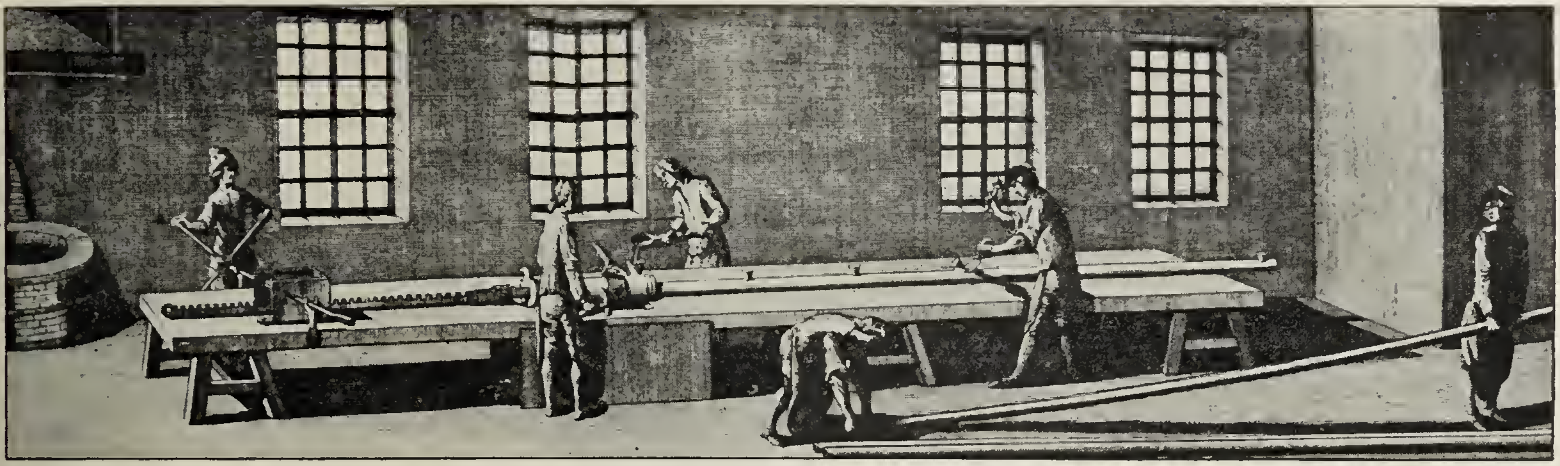

Fig. 17—Casting Seamless Continuous Lead Pipe in France in 1743

The Evolution of the Die Casting Process---II

Casting Bronze Cannon for the American Revolution—Advance of Cast Pipe, Type-Setting and Die-Casting Industries

By Charles W Pack

CASTING large bells formed an important branch of the clay or loam process of molding metal. This industry seems to have started in the monasteries. The first laymen bell founders journeyed to a place where a bell was to be cast.

The casting of a large bell is illustrated in Fig. 15. Large bells were constructed over a base in a pit. A compass on a stake was pivoted in the center of the base and to the compass was fastened a templet to give the curve of the bell. A brick core, covered with clay, into which calves' hair had been mixed was raised on the base. By revolving the compass and smallest templet the clay was formed to the dimensions of the inside of the bell or core. This was smeared with grease, and then was covered with a layer of clay which was turned by a larger templet into a clay bell.

Any inscriptions were molded on the outside of this clay bell, usually in wax. The clay bell, in turn, was smeared with grease and was first covered with fine and then with coarse clay to form a solid mantle or outside mold. The whole was then baked. After this, the mantle or cope was lifted, as shown in Fig. 15, and the clay or false bell was taken off, or if necessary, broken off. The mantle was then let down again, leaving an open space between it and the core exactly the size of the bell. The molds then were packed in the pit with sand and earth and the metal which had been melted in the furnace run into them.

A view in the furnace room is

Presented at the Cleveland meeting of the Institute of Metals, September, 1916. The author, Charles W. Pack, is with the Doehler Die Casting Co., Brooklyn, N. Y.

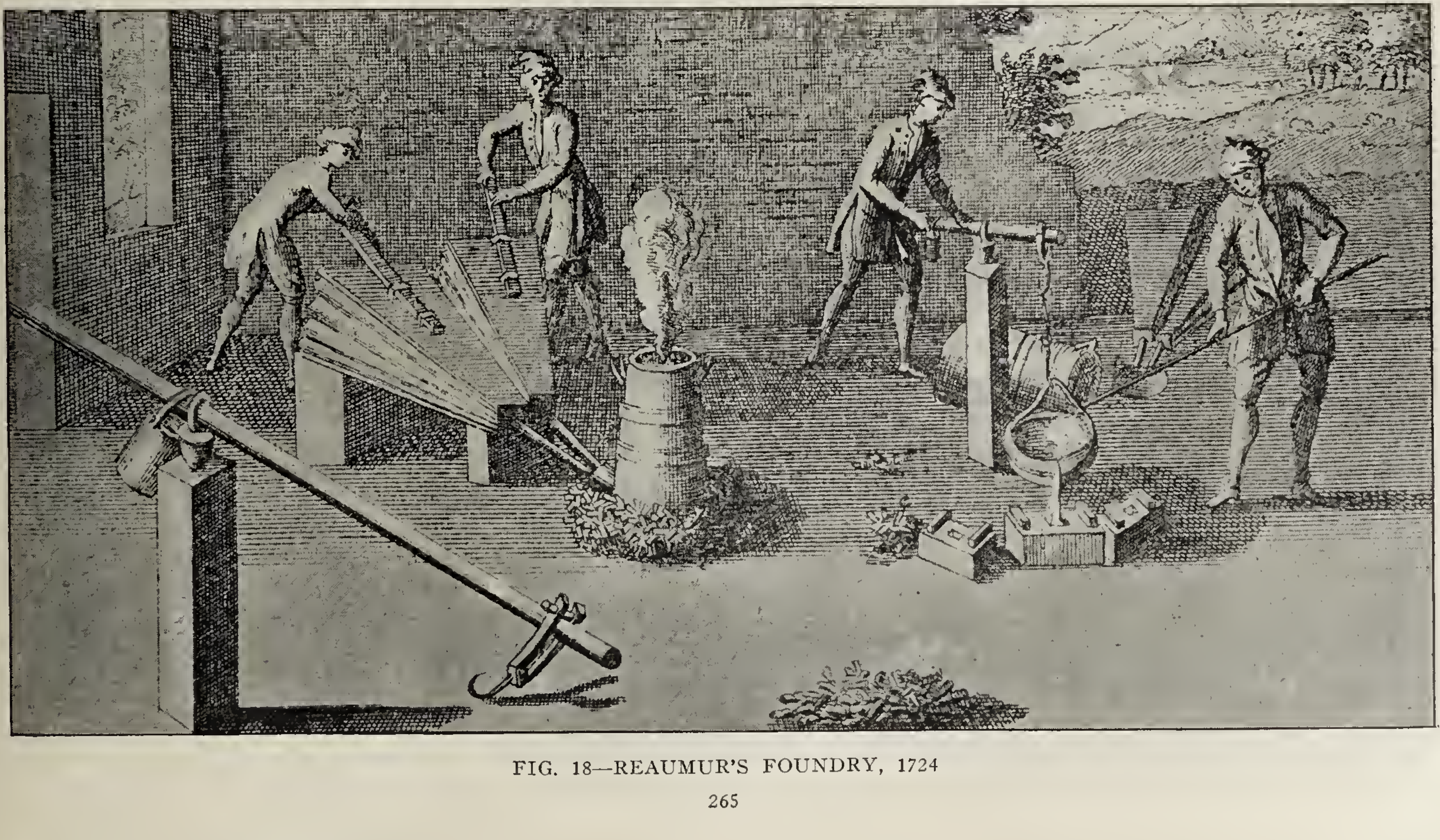

FIG. 18—REAUMUR'S FOUNDRY, 1724

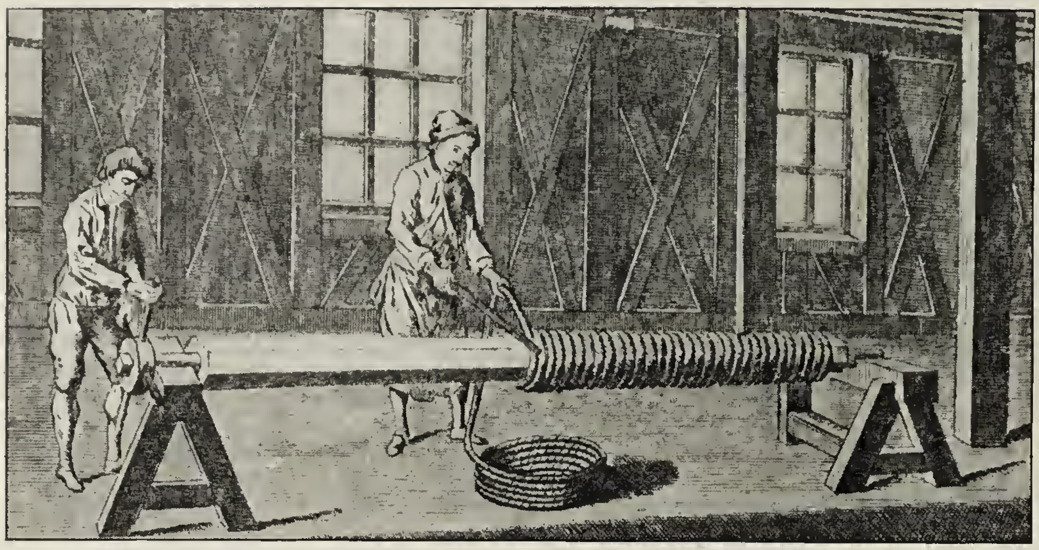

FIG. 19—CASTING BRONZE CANNON, 1775—MAKING CORE

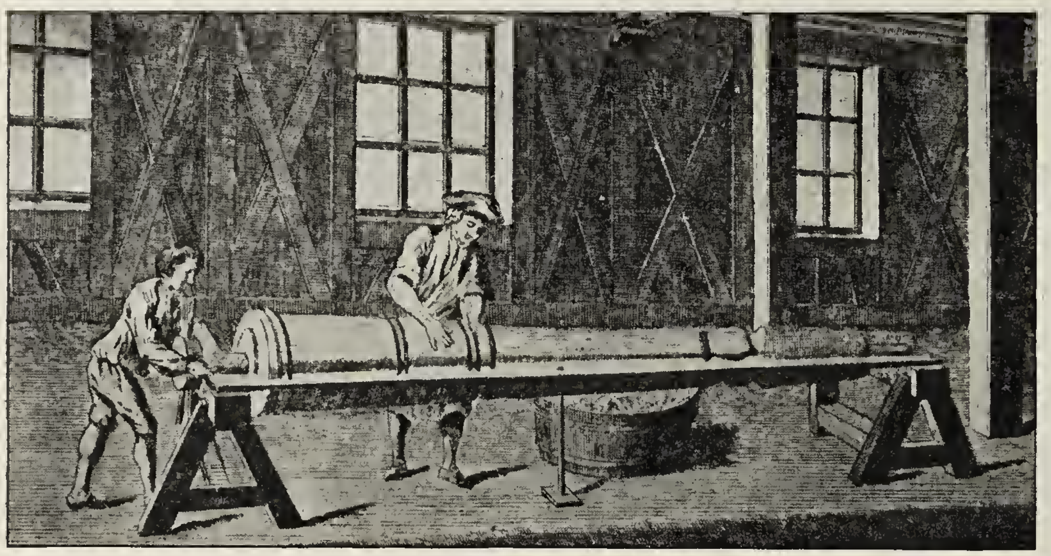

FIG. 20—PUTTING ON FIRST CLAY FOR CORE

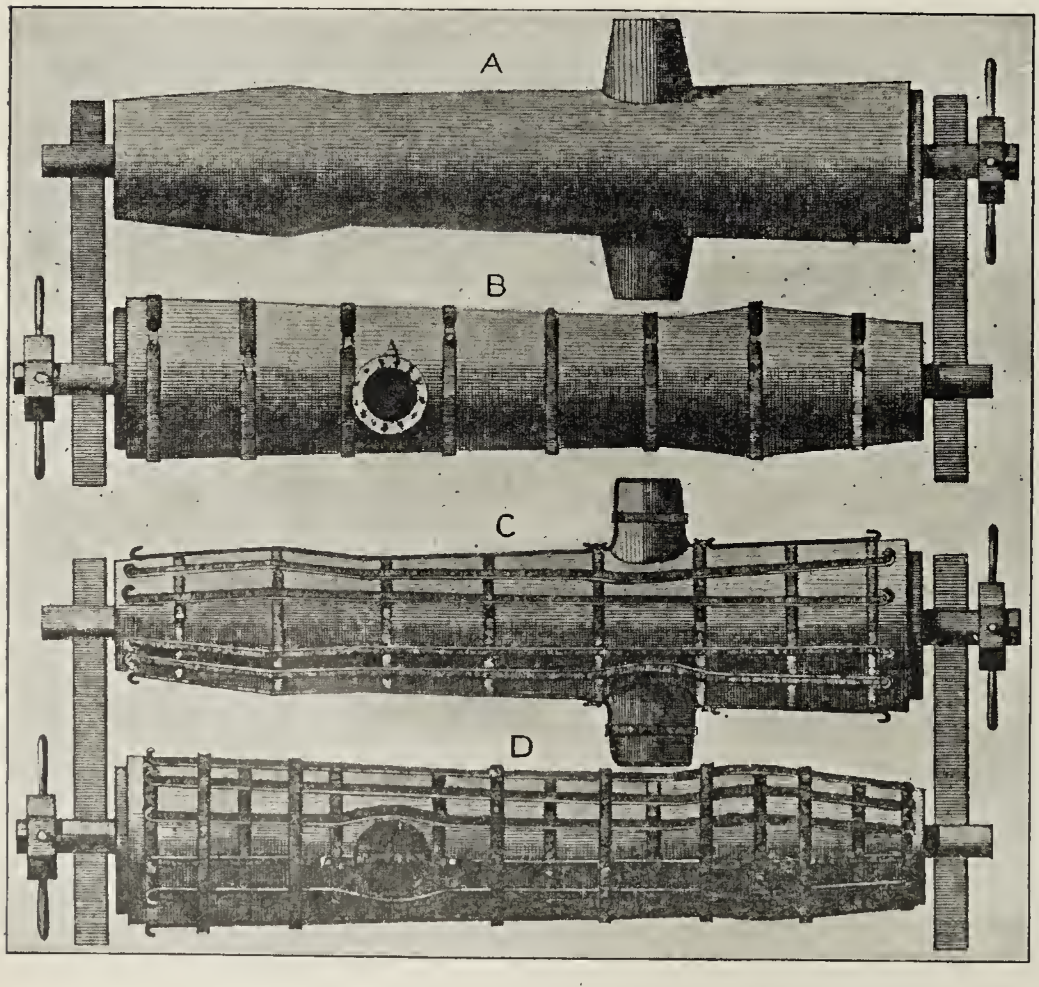

FIG. 21—PROGRESS IN APPLYING SECOND CLAY FOR CANNON MOLD

shown in Fig. 16. The metal was run through a trough into the pit below, the trough being so arranged that a number of bells could be poured in succession. The two-bell casting pictures reproduced as Figs. 15 and 16 are dated 1775, and the process illustrated undoubtedly was used for the casting of the Liberty Bell in 1776.

Early Munitions Makers

The manufacture of arms and munitions is playing such an important part in the foundries and machine shops today that it will be of more than unusual interest to study the munition shops of the eighteenth century to learn the process then in use for casting bronze cannon, some of which were used in the Revolutionary war in 1775.

Fig. 19 represents the first step in this process which may be described briefly as follows: The wooden spindle was wound with hay rope to a size approximating that of the cannon. The next step, which is illustrated in Fig. 20, was to apply clay to form the outside of the cannon which was cast solid. The bench used in applying the clay and the position of the templet is clearly indicated. The core was then greased and another layer of clay to form the outside of the mold was applied, as illustrated in Fig. 21. *A* shows the mold as it appeared after the second or outer coat of clay had been applied and the molds to form the lugs of the cannon had been attached; *B*, *C* and *D* show the method of banding the outside. Fig. 22 illustrates the mold banded and ready for the drying which is shown in Fig. 23.

Collapsible Cores

When the mold had been completely dried, the spindle and rope were withdrawn causing the inside layer of clay to collapse which was blown-out leaving the void to be filled in by the solid cannon. A view of the furnace room is shown in Fig. 24. The furnace is of the type that was used extensively during the colonial period.

Molding in sand as a commercial method began about 1708. Abraham Darby, in Wales, had been having considerable trouble in casting hollow iron vessels, when a boy by the name of John Thomas conceived the idea that the use of sand instead of clay would better let out the air from the casting and avoid the destruction of many molds. They stayed until after working hours and made some successful experiments with the new method. Thomas was later taken into partnership and the firm continued to use this plan. In England a patent for sand molding was allowed by the government in 1758.

One of the pioneers in the sand-casting art was Reaumur, the French scientist and originator of the system of temperature measurement that bears his name. A view in his foundry is shown in Fig. 18. The hand bellows, as shown in operation, and one furnace are working, the other having just been emptied. The man at the right is pouring-off the molds. The unique crane arrangement for handling the crucible used by Reaumur is shown in the foreground at the left.

Fig. 26 is a view of a French statuary shop, dated 1760. Here the molds were carved by hand, assembled and poured. The most distinctive feature of this illustration is the peculiar method of gating shown at the left. A series of gates at different heights of the casting was provided. Pouring was begun at the lowest gate which was plugged and the gate above then was poured and plugged, and so on until the casting was filled. The object of this method of gating was undoubtedly to insure the removal of gases and to reduce segregation to the minimum.

Metal Molds

There seems to be little doubt but that the metal mold was first used for casting type since the advent of printing brought with it a demand for a cheap method for producing type. Pewter had come into extensive use for tableware during the fifteenth century and was highly fashionable during the colonial period. This industry provided another opening for the use of metal molds.

Seamless lead pipe was made in metal molds during the first half of the eighteenth century. Fig. 25, reproducing a picture dated 1775, shows a shop where pewter kettles were cast. The furnace is in the background. Two men are shown pouring a pot at the left. The heavy threaded apparatus used for withdrawing the core also is shown at the left. The two men at the right appear to be broaching the hole to provide a snug fit for the cover. A finished casting is in the foreground.

Seamless Lead Pipe

Fig. 17 shows a shop where seamless lead pipe was cast in 1743. The mold was constructed in two halves and was fastened together by clamps. The core was fastened to a rack operated by a pinion shown at the left. The metal was poured through the opening of the mold, and when the metal had set sufficiently, the

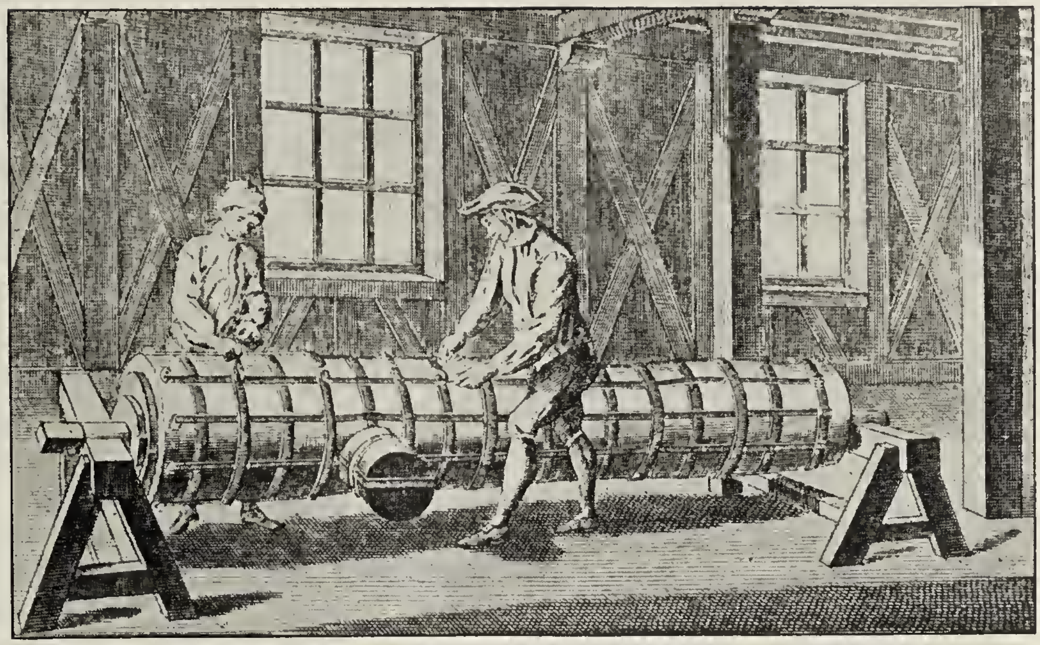

FIG. 22—BONDING SECOND CLAY FOR CANNON

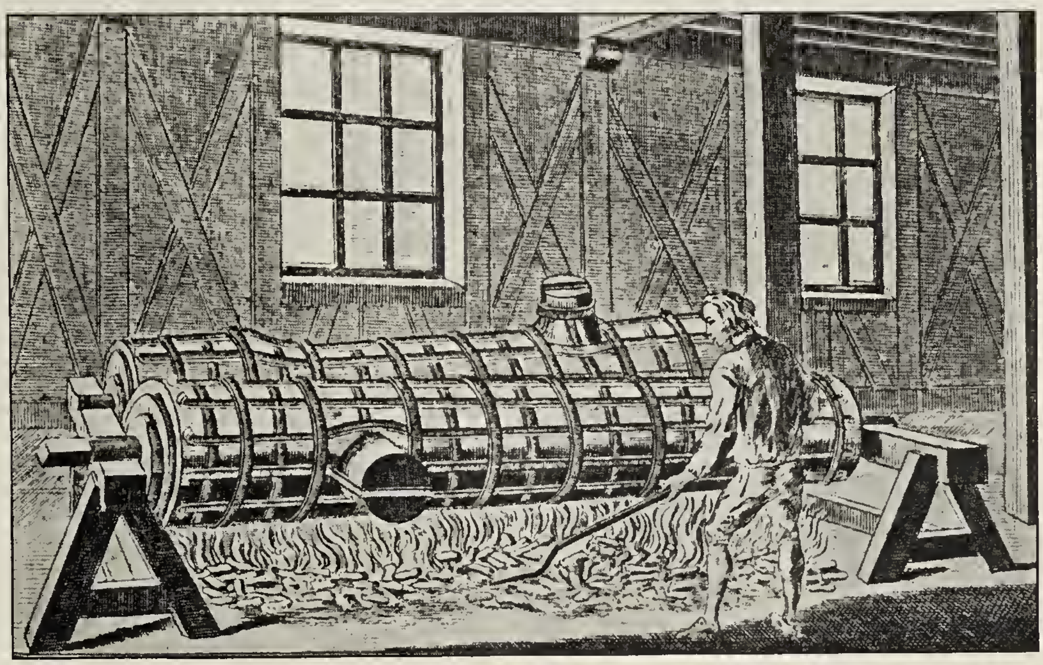

FIG. 23—BAKING THE BONDED MOLD

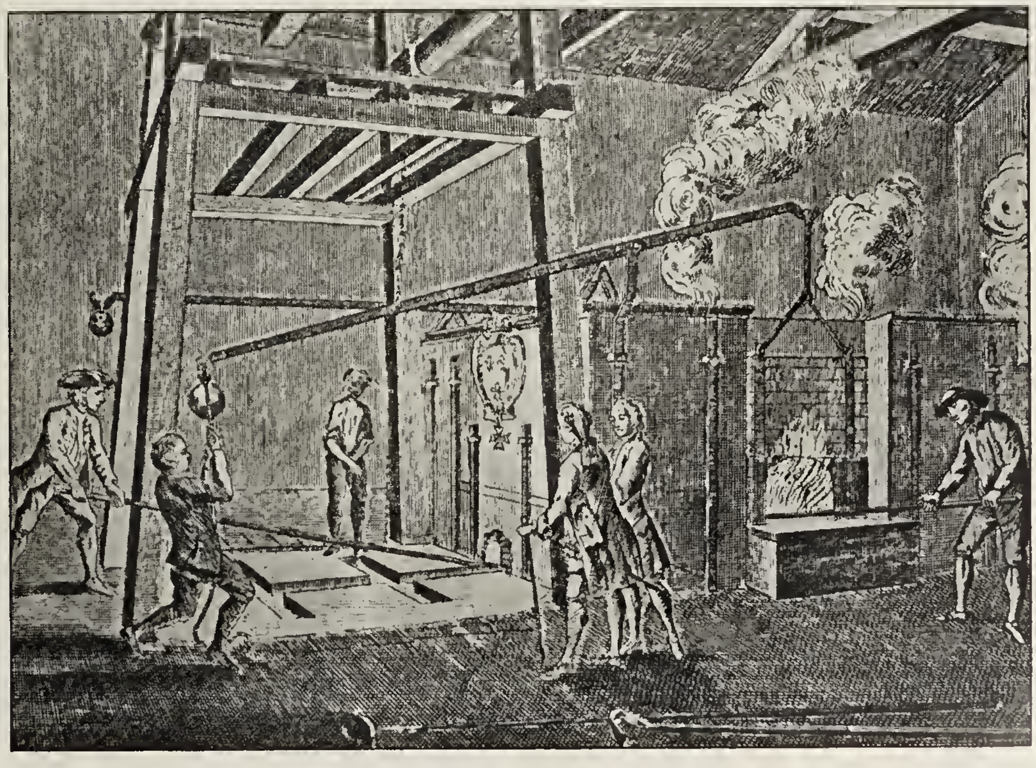

FIG. 24—FURNACE FOR MELTING METAL FOR CANNON

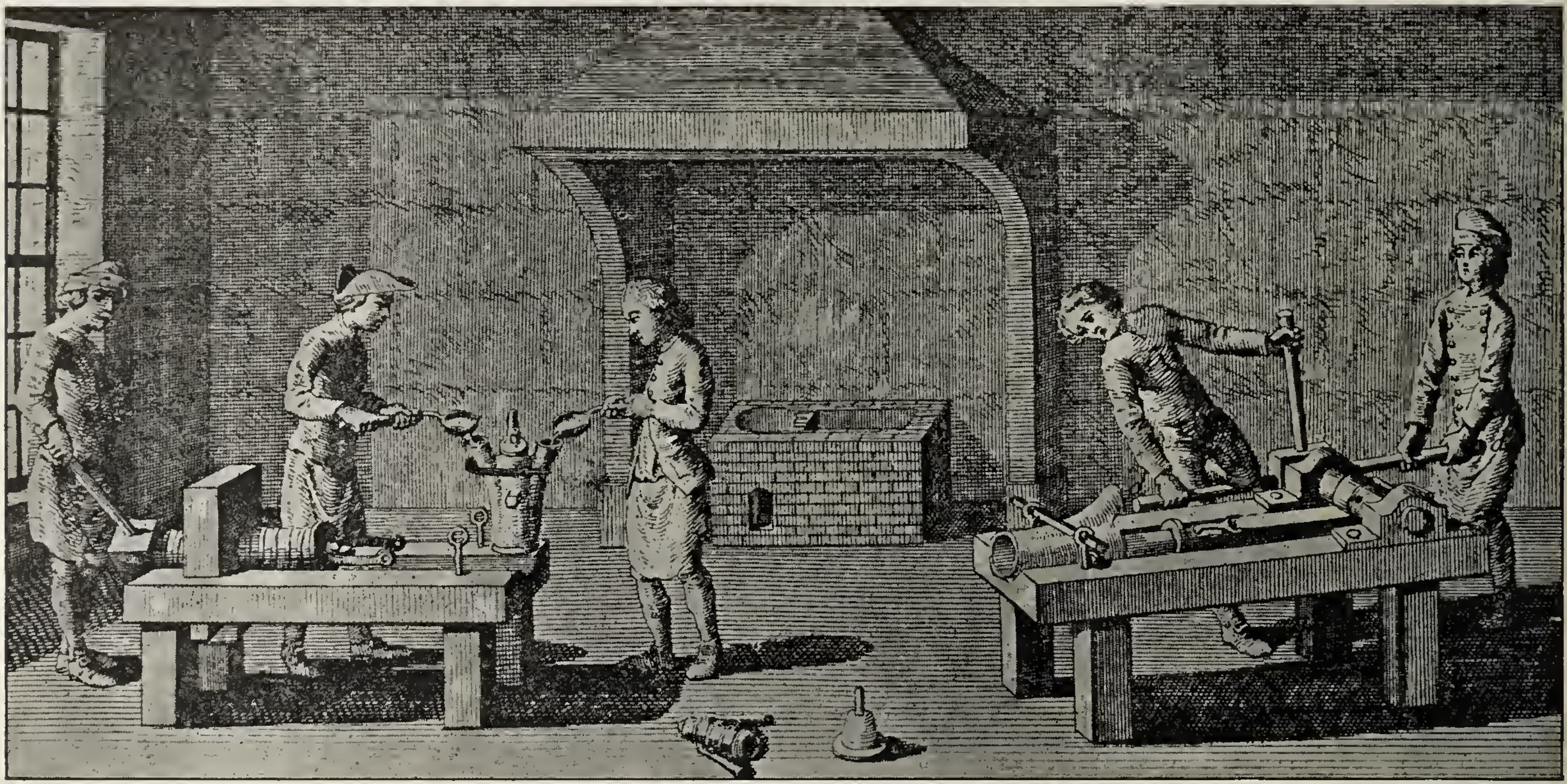

FIG. 25—CASTING PEWTER, 1755

core was withdrawn, the clamps removed and the mold opened. The casting then was moved down the bench to another position. To make the next piece, one end of the previous casting was clamped in the mold, the core then was replaced and the metal poured. Conditions were so regulated that the metal running into the mold melted the end of the previous casting and joined with it, forming a seamless tube. One man worked the rack and pinion for withdrawing the core, two men placed the clamps in position and poured, one man cut off the gates and the other two men removed the finished product. This method, although much slower than the modern extrusion process, answered the purpose very nicely and must be admitted to be a rather ingenious process which required very little and inexpensive equipment.

The Type Casting Industry

The method owes its origin and early development to the type-casting industry established as a most necessary factor to the successful introduction of printing. A type-casting outfit used about 1683 is shown in Fig. 27. The mold was held in one hand by a small leather mold guard and the metal was poured with the other hand. The metal was melted in a small iron pan. Fig. 28 is a view in an American type-casting room with the entire family at work. The picture from which this was reproduced is dated 1800.

Work was begun on the automatic type-casting machine early in the nineteenth century. Church's type caster was an English invention of 1822. It was claimed to be capable of casting 75,000 pieces of type an hour by casting a whole font at each operation. Following this invention came many others too numerous to mention. In 1886 the first linotype

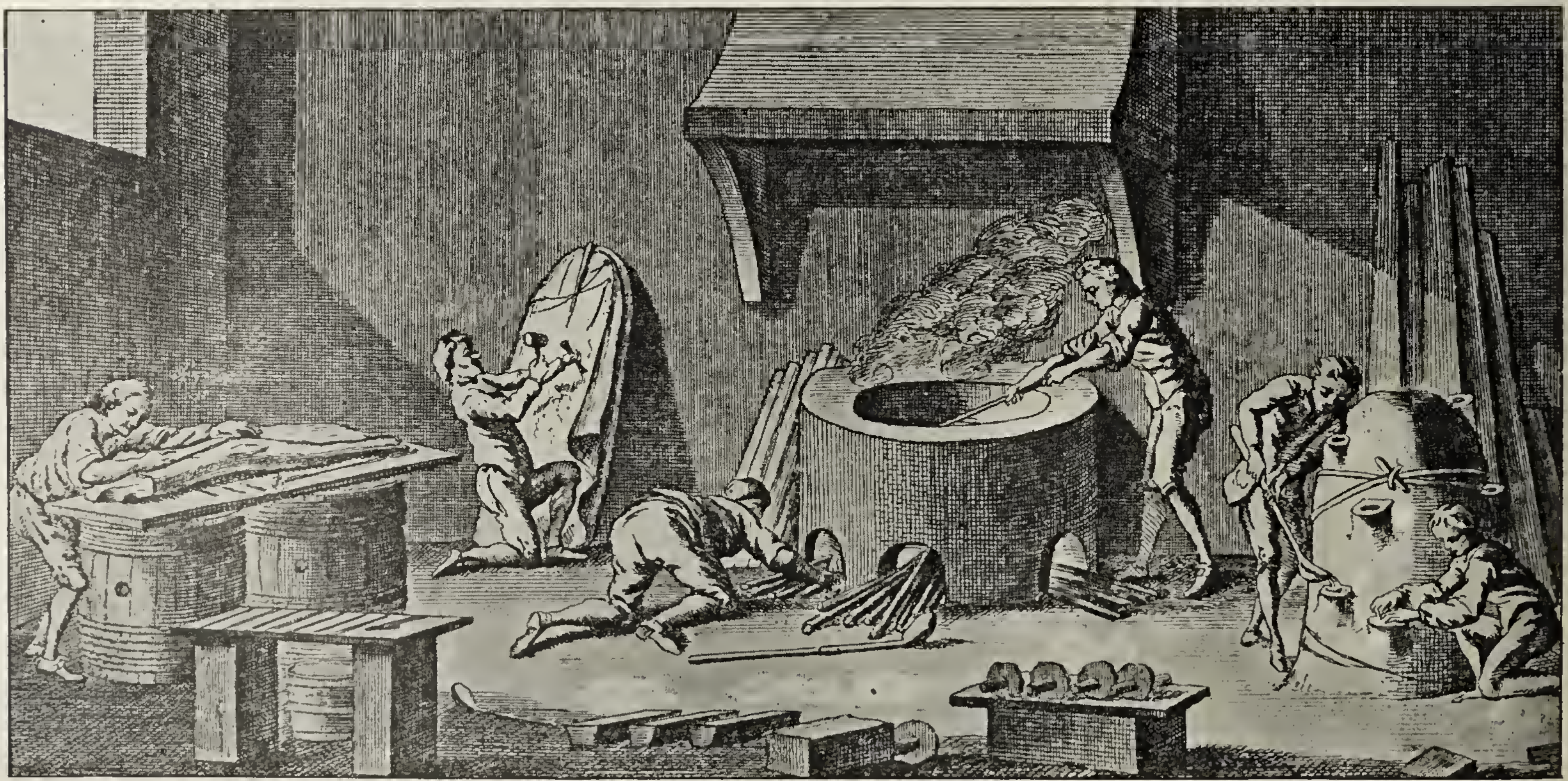

FIG. 26—CASTING IN CLAY, 1760, FRANCE—NOTE POURING GATES ON MOLD

machine with independent matrices was installed. When the matrices have been assembled, forming a complete mold, the metal, which is kept in a fluid state, is automatically forced into the mold by a cylinder and piston arrangement submerged in the metal.

This method of casting, although an important feature of this machine, had been used as early as 1849 for casting type and bullets, as indicated by patent issued to J. J. Sturgis that year. During the second half of the nineteenth century many casting machines were patented using the plunger-type casting principle, but varying in design.

The first record of the application of this principle to the manufacture of die-castings as understood today, appears in a patent issued to B. H. Dusenbury in 1827 for a plunger-type machine used for casting babbitt bearings. Machines of this type, with varying designs, were used for casting tin and lead alloys on a small scale, but the die-casting did not receive recognition as a standard metallurgical product until 1907. The Doehler machine was patented during that year and was widely adopted. The tin and lead alloys were found to be too soft for most purposes and a zinc base alloy was adopted.

Die-castings have been employed for many purposes, among which may be mentioned housings on magnetos; tone arm, elbow and sound box for talking machines; automobile oil pumps, wing nuts, horn, speedometer and many other parts of motor vehicles where high tensile strength is not essential; internal and external parts of gum, soap, stamp and cigar vending and labeling machines; and electrical devices, such as oscillating fans, signaling devices, etc.

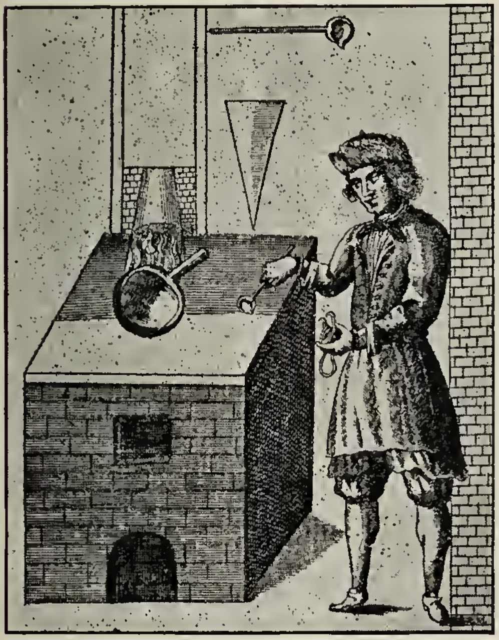

FIG. 27—TYPECASTING IN 1683

Specifications for Wood Patterns

By J. F. Shea

To avoid confusion and misunderstanding when quoting prices on pattern work, and to serve as a guide for making its patterns, the Lake Torpedo Boat Co., Bridgeport, Conn., has prepared specifications covering all of its contract model work, which are as follows:

Owing to the large number of different designs of castings we are compelled to use, the shrinkage varies greatly, and each job of any size and importance is a problem in itself, and should be treated so that the castings will conform to the drawing.

However, unless otherwise notified, the following general instructions should apply—

	Shrinkage, In. per ft.	Colors of patterns.
Composition	5/32	Black prints
Aluminum	5/32	Black prints
Cast iron	1/10	Yellow prints
Lead	3/16	Yellow prints
Cast steel	3/16	Yellow prints
Malleable iron	1/8	Yellow prints
Joint on loose pieces.	....	Red

We have herewith specified three grades of patterns, namely, *A*, *B* and *C*.

The number of castings required from any pattern will determine its grade, and will be shown on the drawing.

Grade A

These patterns and core boxes must be made of mahogany, joints to be screwed and glued.

Fillets should be cut in the job wherever possible, otherwise leather fillets should be used. Screw holes must be counter-bored and plugged.

These patterns must be provided with brass dowels and rapping plates. The cores should be shown by shellac wherever possible. Loose pieces must be dovetailed in place. The patterns must have at least four coats of shellac.

The workmanship should be the best.

Grade B

Pattern and core boxes should be made of well seasoned white pine, except all wearing parts, which should be of mahogany. Loose pieces to be made of mahogany and dovetailed in place wherever possible.

Wood dowels are permissible.

Screw holes to be counter-bored and plugged.

All joints to be well-glued and nailed.

Core must be shown wherever possible.

Wood or leather fillets can be used.

The pattern should have at least three coats of shellac.

Workmanship good.

Grade C

Patterns intended for one or two castings only must be made to check exact with the drawing; otherwise as cheap as foundry permits.

The Refractories Manufacturers' association, with headquarters at 220 South Michigan avenue, Chicago, has endowed a fellowship in the Mellon Institute of Industrial Research, Pittsburgh, which is operated in connection with the University of Pittsburgh. The membership of the Refractories Manufacturers' association is constituted of producers of silica, chrome, magnesite and fire brick. The Mellon institute will make an investigation of the problems of brick manufacture and the results undoubtedly will prove beneficial to the producers of these refractories and to the users as well.

Castings from Acid and Basic Electric Steel

Owing to a typographical error in the article entitled "Castings from Acid and Basic Electric Steel", by A. Walter Lorenz, published in the June issue of THE FOUNDRY, page 220, the statement was made "it is only necessary to raise this manganese 0.50 per cent to secure a product as good as the average converter product of 0.60 to 0.70 per cent manganese." This should have read "it is only necessary to raise this to 0.50 per cent." The sentence as printed conveys the impression that electric steel must contain more manganese than converter steel to be of equal quality. As a matter of fact, for equal physical characteristic, electric steel requires less manganese than converter steel. Electric steel containing 0.40 to 0.50 per cent manganese is equal to converter steel of 0.60 to 0.70 per cent manganese both in soundness and strength.

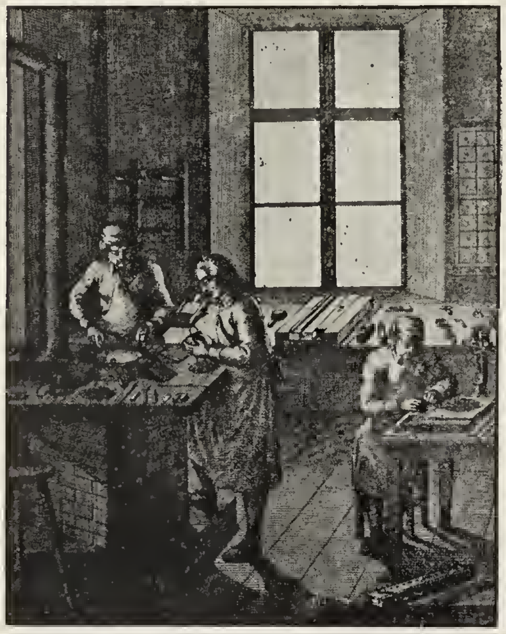

FIG. 28—TYPECASTING IN 1800

An alloy of 85 per cent nickel and 15 per cent chromium, drawn into wire 0.016 inch in diameter, has a resistance of 2.3 michroms per foot. Nickel and chromium alloys are adapted for use at temperatures of from 800 to 1000 degrees Cent.

An alloy of 90 per cent nickel and 10 per cent chromium has a melting point below that of copper and a resistance nearly 50 times that of copper.

Testing Society Considers New Specifications

Committee Reports Submitted at Atlantic City Meeting Extend Scope of Standardization in Producing and Testing Metal Products

TENTATIVE specifications for soil pipe and fittings and for railroad malleable iron castings were submitted at the annual meeting of the American Society for Testing Materials, held at Atlantic City, June 26 to 29. The committee on cast iron, of which Richard Moldenke is chairman, reported that the constantly increasing sulphur content of gray iron castings has resulted in a demand for more latitude in this direction in the specifications of the society. Therefore, it was decided to increase the maximum sulphur limit in light castings from 0.08 to 0.10 per cent. The change from general to special standard specifications for malleable iron castings, predicted last year, has arrived sooner than was expected. The revised specifications adopted in 1915 did not satisfy the demand for all classes of malleable castings. The committee of the Testing society, in co-operation with a similar committee of the American Foundrymen's association, has prepared proposed specifications for railroad malleables and a recommendation was made that the present specifications be retained for the general run of work. The special requirements for conveyor chain links will next be taken up by the sub-committee on malleable cast iron and it is probable that next year tentative specifications will be presented.

Revising Cylinder Standard

The sub-committee on cylinders is at work on the revision of the present standard specifications for cast iron locomotive cylinders, which are to be extended to embrace piston-valve bushings, piston-valve packing rings, piston-valve bull rings, cylinder bushings, piston packing rings and piston head or bull rings. This committee is working with a similar committee from the Master Mechanics' association and it is believed the revision shortly will be completed.

The sub-committee on cast iron car wheels is continuing its work of revising the existing standards and another committee has undertaken the consideration of the standard screen scale for testing sieves, recommended for adoption by the United States Bureau of Standards. The subject of molding sand will be taken up in the near future with the committee on refractories of the Testing society and a committee from the American Foundrymen's association.

One session was devoted to the consideration of nonferrous metals and the report of the committee on nonferrous metals and alloys, presented by William Campbell, chairman, included tentative specifications for nonferrous alloys for railway equipment in ingot, castings and finished car and tender bearings, as well as the revision of the standard specifications for spelter. Other tentative specifications presented included brass for forging rods and free-cutting brass rods for use in screw machines.

W. M. Corse, chairman of the sub-committee on sand-cast metals and alloys, reported that a large amount of interesting data on the following alloys had been collected: Copper, 88 per cent; tin, 10 per cent and zinc 2 per cent; manganese bronze; copper, 80 per cent, tin 10 per cent and lead 10 per cent; copper, 90 per cent and aluminum, 10 per cent, and aluminum. 92 per cent and copper, 8 per cent. The report of the tests of these alloys is given elsewhere in this issue.

G. H. Clamer, chairman of the sub-committee on white metal, stated that it is highly desirable that no specifications for white metal shall be recommended until standard methods of analysis and sampling are agreed upon.

In the proposed revision of the standard specifications for spelter, the limit for cadmium in high grade spelter was increased from 0.05 to 0.07 per cent. The limit for lead in prime western grade spelter was increased from 1.50 to 1.60 per cent and the limit for iron was increased from 0.06 to 0.08 per cent. Changes also were made in the paragraphs relating to the method of sampling.

Alfred D. Flinn and Ernst Jonson were the joint authors of a paper entitled, "Inspection of Brass and Bronze".

Papers on Wrought Brass

In his paper on the "Interior Surface Defects on Brass Condenser Tubes as a Cause for Corrosion", W. Reuben Webster, stated that it is the belief of some engineers that defects on the interior surface of brass condenser tubes act to accelerate corrosion and accordingly their presence, even to a small degree, should not be tolerated. Extended observation has failed to furnish a basis for such belief. The variety of corrosion which exhibits itself in local pitting resulting in perforation, takes place independently of any interior defects which may exist and no tendency of the pitting to localize at a surface defect has been observed. Productions and photographs of the interior surfaces or corroded tubes, both with and without defects of any character, were shown, which clearly indicates that corrosion takes place independent of these defects.

Other papers presented included the following: "The Hardness of Hard-Drawn Copper," by E. H. Peirce; "The Electrolytic Determination of Tin on Tinned Copper Wire," by George G. Grower; "Light Versus Heavy Reduction in Cold-Working Brass", by W. Reuben Webster, and "The Testing of Sheet Brass", by Charles H. Davis.

Tentative Specifications for Soil Pipe and Fittings

1.—The cast iron from which the pipe and fittings are made shall be of such composition, and the conditions of manufacture so maintained, that the castings will be of uniform physical character, close-grain, not hard, brittle nor difficult to cut with file or chisel.

2.—(*a*) When pipe or fittings are to be coated, coal tar pitch shall be used, which shall contain sufficient oil to make a smooth coating. The pitch shall be tough and tenacious when cold, and not brittle nor having any tendency to scale.

(*b*) The varnish shall be heated to about 300 degrees Fahr., and shall remain at this temperature during the time the casting is immersed.

(*c*) Each casting shall be heated to a uniform temperature of about 300 degrees Fahr. immediately before it is dipped, and shall possess this temperature at the time it is put in the bath.

(*d*) Each casting shall remain in the bath at least two minutes.

(*e*) Fresh pitch and oil shall be added when necessary to keep the mixture of the proper consistency, and the vat shall be emptied of its contents and refilled with fresh pitch whenever the accumulation of sand or carbonaceous matter renders this desirable, as can be seen by the adhering solids to the under side or lower ends of the castings.

(*f*) After being coated the pipe and fittings shall be carefully drained of the surplus varnish.

Chemical Properties and Tests

3.—Drillings taken from the fractured end of the arbitration test bar shall not contain over 0.10 per cent of sulphur.

Physical Properties and Tests

4.—From each melt of metal not less than three test specimens shall be poured, the first of which shall be poured within five minutes after the first ladle is tapped and the remainder at intervals not exceeding one hour throughout the melt.

5.—The mold for the arbitration bars is shown in the accompanying illustration. The bottom of the bar is $\frac{1}{16}$ inch smaller in diameter than the top, to allow for draft and for the strain of pouring. The pattern shall not be rapped before withdrawing. The flask is to be rammed up with green molding sand, a

(*Continued on page 294*)

Presented at the annual meeting of the American Society for Testing Materials.

Results of Tests of Sand-Cast Metals and Alloys

Data From Authorities on Nonferrous Metals Show Physical Properties of Five Important Alloys—No Specifications Were Submitted

For the purpose of accumulating data on various alloys from reliable sources, a sub-committee of the general committee on nonferrous metals and alloys of the American Society for Testing Materials, has obtained information from a number of expert brass foundrymen on the following alloys:

1—*Copper,* 88 *per cent; tin,* 10 *per cent, and zinc,* 2 *per cent.*
2—*Manganese bronze.*
3—*Copper,* 80 *per cent; tin,* 10 *per cent and lead,* 10 *per cent.*
4—*Copper,* 90 *per cent and aluminum,* 10 *per cent.*
5—*Aluminum,* 92 *per cent and copper,* 8 *per cent.*

The appended reports from the different authorities, were presented at the annual meeting of the society, held at Atlantic City, June 26 *to* 29, *by W. M. Corse, secretary of this sub-committee.*

No attempt was made to prepare specifications, the data having been presented as results which can be obtained when these alloys are cast by the methods described. The report stated, that it is a well-known fact that these physical properties, while comparative for the alloys investigated, cannot be expected to represent the physical properties of the metal in a casting. The results given cannot be used by engineers to calculate the strength of the materials, except with a liberal factor of safety, because the physical properties of a casting are largely dependent on its size and form. In the opinion of the sub-committee, the value for tensile strength and yield point of actual castings are only 50 *per cent of those values obtained with these test bars.*

The 88-10-2 Alloy

Data from L P Webbert

THIS alloy is commonly known as the 88-10-2 alloy, government bronze, United States navy gun bronze and government composition *G*. In England it is known as admiralty gun metal, gun metal and gun bronze. The alloy contains copper, 87 to 89 per cent; tin, 9 to 11 per cent, and zinc, 1 to 3 per cent.

The impurities present in this alloy are iron, not exceeding 0.10 per cent; sulphur, not exceeding 0.05 per cent, and lead, not exceeding 0.50 per cent. Aluminum and antimony are not allowed to be present in this alloy even in small quantities.

The presence of a small quantity of lead, not over 0.50 per cent, improves the machining qualities of this metal.

The physical properties of this alloy are as follows:

Specific gravity at 20 degrees Cent. (68 degrees Fahr.)................	8.7
Weight per cubic inch, pounds........	0.314
Brinell hardness number, 500 kg. load, 10 mm. ball (sand-cast metal, unannealed)	70
Scleroscope hardness number..........	12–15

The highest tension test observed, using this type of test specimen, was 58,450 pounds per square inch with an elongation of 2 inches of 55.5 per cent. Specifications allow a minimum tensile strength of 33,000 pounds per square inch and a minimum elongation of 2 inches of 14 per cent.

Linear contraction from liquid to solid, using a bar 12 by 1 by 1 inch, inches per feet, 0.13.

Melting point, 995 degrees Cent., (1825 degrees Fahr.)

Casting temperature, 1175-1245 degrees Cent. (2150-2275 degrees Fahr.)

Thick castings take the lower temperature. Thin castings take the higher temperature.

The test specimen most convenient to attach to castings is shown in Fig. 1. This type of specimen receives the same heat treatment as the casting and is free from defects.

A test specimen 0.505 inch in diameter, as shown in Fig. 1, would represent quite closely the strength of a casting of ½ inch thickness. A test specimen 0.798 inch in diameter, similar to the specimen of 0.505 inch in diameter, would give a lower tensile strength and would represent quite closely the strength of a casting ¾ inch thick.

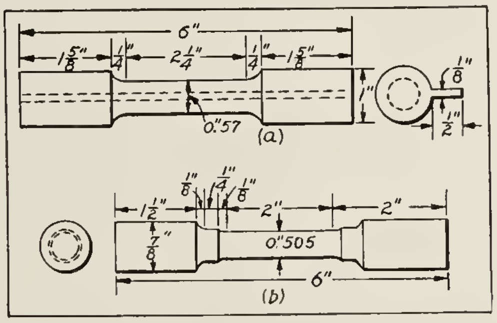

FIG. 1—TEST SPECIMEN FOR 88-10-2 ALLOY

The designer of a casting should note that the average strength of a thick casting in pounds per square inch is lower than that of a thin casting. This is due to the fact that the surface of a casting, commonly called the skin, possesses the highest tensile strength. From the skin inward the tensile strength and elongation decrease. A test specimen of the type shown in Fig. 1 attached to a casting may give a tensile strength of 40,000 pounds per square inch, whereas a test specimen cut from the interior of the same casting may give a tensile strength as low as 25,000 pounds per square inch. The designing engineer should pay particular attention to those parts of a casting where the skin is removed in machining, leaving the weaker metal.

The test specimen, as shown in Fig. 1, attached to a casting is practically a cast-to-size test coupon and gives a higher tensile strength than the average

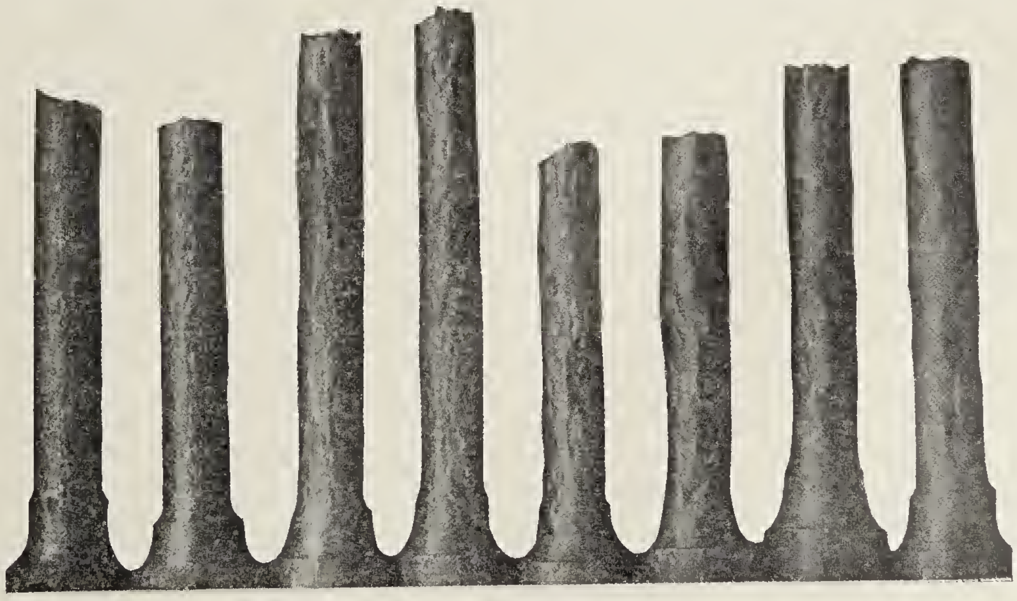

FIG. 2—SPECIMENS OF 88-10-2 ALLOY

strength of the casting. The specimen receiving the same heat treatment as the casting affords a means of examining the heat treatment received by the casting. Fig. 2 shows the appearance of the surface of eight test specimens, selected from a large number of castings, after being pulled. These castings were made in dry sand and were allowed to cool in the mold. The specimens are arranged to show the relation existing between the condition of the surface of the pulled test specimen and the heat treatment received. It has been shown that a similar relation exists between the surface of a steel test specimen after being pulled and the heat treatment received. The casting temperatures of specimens Nos. 6, 7 and 8 were too high. With specimen No. 1, the heat introduced into the mold approaches the amount necessary to anneal the casting properly. Beyond specimen No. 1, the specimens show decreasing tensile strength and elongation, and at the extreme end, if we could complete the arrangement of specimens, we find specimens showing a grayish fracture with very low elongation and showing an almost smooth test specimen.

The accompanying table gives the physical properties of the specimens.

PHYSICAL PROPERTIES OF SPECIMENS SHOWN IN FIG. 2

Specimen No.	Yield point,[1] pounds per square inch	Tensile strength, pounds per square inch	Elongation in 2 inches, per cent
1	18,500	54,500	53
2	18,000	52,800	50
3	19,500	52,000	61
4	17,500	51,000	56.5
5	17,000	50,300	75.5
6	17,500	47,400	49
7	18,500	41,300	29
8	18,500	40,000	29.5

---

[1] The dividers were used in obtaining the yield point. The values given are approximate.

Properties of Manganese Bronze

Data from N K B Patch

THE chilled cast bar used was made from a 1-inch square bar poured in an open chill and then machined to size. The sand cast bar was cut from the standard A. S. T. M. No. 4 bar with three coupons. Following are the physical properties of the bars:

	Sand-cast	Chill-cast
Tensile strength, lb. per sq. in.	70,000–75,000	75,000–80,000
Elongation in 2 in., per cent	22–30	25–32
Brinell hardness	109–119	119–130
Specific gravity	8.4	....
Wgt. per cu. in., lb.	0.30	....
Electric conductivity, per cent, about	22	....
Modulus of elasticity, lb. per sq. in.	14,000,000	....
Shrink., in. per ft.	¼	....

Elongation in 2 inches, per cent:

Sand-cast	22–30
Chill-cast	25–32
Weight, sand cast, pounds per cu. in.	0.3009
Shrinkage, inches per foot	¼

It is noticeable that the tensile strength of the chill cast specimen exceeds that of the sand-cast by 5000 pounds.

Conductivity and Hardness of Manganese Bronze

Data from J. L. Jones

Tests for the electrical conductivity for manganese bronze gave the following results:

Degrees, Cent.	Per cent
23	27.7
21.8	27.4
21.6	27.5

Results of 22 tests for Brinell hardness on 3 samples were as follows:

Maximum	113.6
Minimum	96.3
Average	105.0

Strength and Elongation of Manganese Bronze Specimens

Data from J. A. Capp

Manganese bronze castings were supplied in the form of cylindrical bars about 1½ inches in diameter and 24 inches long. They were machined to about 1 inch in diameter and 8 inches long between shoulders for extensometer tests; or about ½ inch in diameter and 2 inches long between shoulders for commercial tests. The results are given in the accompanying table.

RESULTS OF TESTS ON MANGANESE BRONZE BARS MADE BY J. A. CAPP

	Extensometer test			Commercial test			
Bar No.	Elastic limit, pounds per square inch	Modulus of elasticity, pounds per square inch	Elongation in 8 inches, per cent	Yield point pounds per square inch	Tensile strength pounds per square inch	Elongation in 2 inches, per cent	Reduction of area, per cent
9902 *B*	16,000	12,390,000	31.6	26,000	69,650	32.5	40.8
9902 *B*	15,000	12,900,000	27.5	......	......	....	....
9902 *A*	21,400	....	27.2	25.000	67,940	42.0	54.8
9902 *A*	16,000	13,000,000	27.8	......	......	....	....
9908 *B*	23,000	13,300,000	10.6	29,000	80,420	26.5	28.5
9908 *A*	22.900	....	6.6	26,000	70,900	14.5	22.4

The Physical Properties of Manganese Bronze

Data from G. H. Clamer

The chemical analyses of eight typical manganese bronzes are as follows:

	Maximum, per cent.	Minimum, per cent	Average, per cent
Copper	59.80	57.44	58.72
Zinc	40.26	37.59	39.05
Tin	1.03	0.59	0.79
Iron	1.39	0.80	1.06
Manganese	0.05	0.03	0.038
Aluminum	0.80	0.19	0.47
Lead	0.20	0.05	0.12

For tension tests, the sand-cast specimens were taken from the bottom of regulation wedge-form of test block, and the chill samples were cut from the bottom of ingots cast in open molds. The physical properties determined are as follows:

Tensile strength, pounds per square inch:

Sand-cast	70,000-75,000
Chill-cast	75,000-80,000

Properties of the 80-10-10 Alloy

Data from N K B Patch

THE physical properties for both sand-chill and chill-cast specimens of the 80-10-10 alloy are given in the accompanying table. Specimen No. 1 was tested by the Lumen Bearing Co. This alloy contained 0.2 per cent of phosphorus. The sand-cast specimen was made from a cast-to-shape standard 2-inch by 0.505-inch test bar. Tests on the chill-cast specimen were made on a 1-inch square test bar machined to a standard 2-inch by 0.505-inch bar, cast in an iron mold.

Specimen No. 2 was tested by the Ajax Metal Co. The tests on this specimen were made from a block cast in sand, the specimen being machined before testing. The test block was gated at the bottom, the upper part of the wedge being a cross-section to act as an adequate riser for the poured metal.

Specimen No. 3 was tested by the Titanium Alloys Co. Tests on sand-cast specimens were made on bars cast-to-shape. No record was made of the bar used for the chill cast.

Specimen No. 4 was tested by the Westinghouse Electric & Mfg. Co. This alloy contained 0.35 per cent of phosphorus. Tests were made from a standard 2-inch by 0.505-inch test bar machined from a sand-cast specimen. Hardness tests were made on a specimen 2 inches in diameter by ¾ inch thick.

It should be noted that the variation in elongation and reduction of area as given by the different tests would indicate some slight variation in the analyses or composition of the material. This may be explained by the difference in the amount of phosphorus used as a deoxident or it may be possible that some of the manufacturers use another deoxidizing agent which has no hardening effect.

The tensile strength of sand cast specimens ranged from 26,000 to 37,000 and that of the chill cast specimens varied from 30,000 to 42,000 pounds.

PHYSICAL PROPERTIES OF THE ALLOY; COPPER, 80 PER CENT; TIN, 10 PER CENT; ZINC, 10 PER CENT

Sand-Cast

Physical property	Specimen No. 1	Specimen No. 2	Specimen No. 3	Specimen No. 4	Average	Minimum	Maximum
Tensile strength, lb. per sq. in.	26,000–32,000	33,130	30,000–37,000	30,000*	31,407	26,000	37,000
Yield point, lb. per sq. in.	21,000–26,000	......	16,000–23,000	20,000*	21,200	16,000	26,000
Elongation in 2 in., per cent	4–8	28	5–18	8	13.6	4	28
Reduction in area, per cent	4–9	28.08	6–16	9	12.02	4	28.08
Brinell hardness	61–70	......	55–60	71	63	55	71
Specific gravity	8.9	8.8†	9.0	8.70	8.85	8.7	9.0
Wght. per cu. in., lb.	0.322	0.3182	0.33	0.314	....	....	....
Shrinkage, per ft., in.	0.125	0.125	0.125	0.122	....	....	....
Elastic limit in compress., lb. per sq. in.	15,000	23,000	1,150–1,200	......	......	......	......
Elastic limit in tension, lb. per sq. in.	......	19,020	.....	13,500	....	....	....
Compression per sq. in., at 15,000 lb. in., per in.	0.001	......	.....	......	....	....	....
Compress. per sq. in. at 50,000 lb. in., per in.	0.100	......	.....	......	....	....	....
Compress. per sq. in. at 100,000 lb. in., per in.	.....	......	0.30–0.35	......	....	....	....
Coefficient of expansion, per deg. Cent. from 1-100	.....	......	0.0000188	0.0000187	....	....	....
Electric conductivity, per cent	.....	......	.....	6.5	....	....	....
Resistance, microhms per cu. in.	.....	......	.....	9.656	....	....	....
Melting point, deg. Cent.	.....	......	.....	872	....	....	....

---

*Average.

†Calculated from weight per cubic inch of 0.3182 lb.

CHILL-CAST

Physical property	Specimen No. 1	Specimen No. 2	Specimen No. 3	Specimen No. 4	Average	Minimum	Maximum
Tensile strength, lb. per sq. in.	36,000–42,000	......	30,000–33,000	......	35,250	30,000	42,000
Yield point, lb. per sq. in.	23,000–29,000	......	....	......	26,000	23,000	29,000
Elongation in 2 in., per cent	2–6	......	4–7	......	4.5	2	7
Reduction of area, per cent	1–6	......	....	......	3.5	1	6
Brinell hardness	80–89	......	....	......	85	80	89

Ten Per Cent Aluminum Bronze

Data from W. M. Corse

The chemical composition of three specimens was as follows:

	Specimen No. 1. per cent	Specimen No. 5. per cent	Specimen No. 13. per cent
Copper	90	89	90
Aluminum	10	10	9.9
Iron	..	1	..

Results of tension tests on bars cast-to-size in sand, about ½ inch in diameter and 2 inches long between shoulders, are as follows:

	Specimen No. 1	Specimen No. 5	Specimen No. 13*
Proportional limit, lb. per sq. in.	......	19,800	......
Yield point, lb. per sq. in.	24,000	24,000	25,000
Tensile strength, lb. per sq. in.	70,000	77,000	71,000
Elongation in 2 in., per cent	20	24	21
Reduction of area, per cent	20	25	......

---

*From eighth report, British Institute Mechanical Engineers.

Results of compression tests on cylinders 1 inch long and 1 square inch in cross-section, machined from bars about 1½ inch square, are expressed in terms of load giving compression of 0.1 per cent and compression resulting from a load of 100,000 pounds per square inch. The load is given in pounds per square inch and the compression in per cent, as follows:

	Specimen No. 1	Specimen No. 5
Load giving compression of 0.1 per cent, lb. per sq. in.	19,500	19,000
Compression at load of 100,000 lb. per sq. in., per cent	12	15

Various other physical properties were as follows:

	Specimen No. 1	Specimen No. 5
Brinell hardness	90–100	95–105
Scleroscope hardness	....	25
Shrinkage, in. per ft.	0.22	0.22
Weight per cu. in., lb.	0.27	0.27
Specific gravity at 20 degrees Cent.	7.5	7.5
Coefficient of friction	0.0018	.....
Coefficient of expansion, per degrees Cent.	0.0000171	.....
Electric conductivity at 20 degrees Cent., per cent	....	18.39* 15.47†

Endurance Tests in White-Souther Machine

Revolutions at 36,000 lb. per sq. in., max.	1,000,000
Revolutions at 27,000 lb. per sq. in., max.	10,000,000

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*By mass.

†By volume.

It is noticeable that the data for the two specimens correspond very closely in practically every detail.

Aluminum, 92 Per Cent and Copper, 8 Per Cent

Data from J. L. Jones

Following are physical properties of the alloy of aluminum and copper as determined in three laboratories:

	Westhouse Elec. & Mfg. Co.	U. S. bureau of mines	Lumen Bearing Co.
Tensile strength, lb. per sq. in.:			
Chilled	......	......	20,000–24,000
Sand	19,800	......	16,000–20,000
Poured hot	......	15,500	....
Poured cold	......	20,000	....
At 500 ° Fahr.	......	19,300	....
Yield point, lb. per sq. in.	15,400	......	....
Elastic limit, lb. per sq. in.	5,000	13,000	....
Elongation in 2 in., per cent	0.8	1.5	1–2
Reduction of area, per cent	4.9	......	....
Transverse strgth, lb. per sq. in.	......	290	....
Transverse deflection, in.	......	0.22	....
Impact resistance, blows:			
4.7-lb. hammer	300	......	....
2.3-lb. hammer	7,000	......	....
Brinell hardness	50	......	....
Specific gravity	2.83	2.84	2.8
Wgt. per cu. in., lb.	0.102	......	0.10
Shrinkage, in.	0.175*	......	$\frac{3}{16}$†
Coefficient of expansion per deg. Cent., 0 to 100 degrees	0.0000240	......	....
Resistance, microhms p'r cu. in.	1.609	......	....
Conductivity, per cent	39	......	....
Mach. qualities	......	§	....
Hot shortness:			
At 1300° Fahr.	......	235‡	....
At 1500° Fahr.	......	90‡	....

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*In 12 by 1 by 1-in. bar.

†Inches per foot.

‡Norton, Transactions, American Institute Metals, Vol. 8, p. 124 (1914).

§Soft and gummy.

Booth-Hall Co. Will Build Electric Furnaces

The Booth-Hall Co., 565 West Washington boulevard, Chicago, has been organized to engage in the building of electric furnaces. C. H. Booth has been elected president and general manager; Julius R. Hall will be vice president; F. J. Sheldon, secretary; and W. D. Walker, sales manager. W. K. Booth has been appointed metallurgist. All of the members of this firm formerly were affiliated with the Snyder Electric Furnace Co. Patents have been applied for on an electric furnace to be designed in three different types to meet the metallurgical conditions of the individual customer and to operate one, two or three-phase. A contract already has been closed, for a 4-ton, 2-phase furnace which is to be the first unit to be installed by a newly organized electric steel company.

B. W. Pharis has been appointed foundry superintendent of the American Blower Co., Detroit.

The Early Use of Permanent Molds for Castings

How the Employment of Ferromanganese, Ferrosilicon, Chills and Permanent Iron Molds Affects the Properties of Castings

By Alexander E Outerbridge Jr

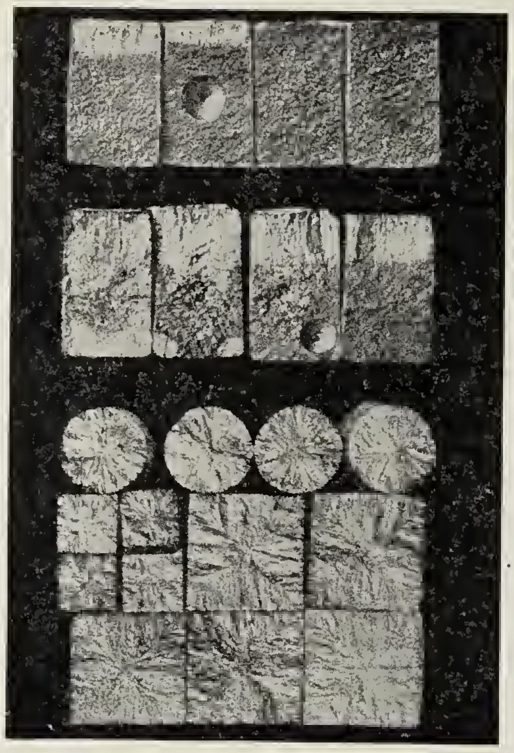

FIG. 1—FRACTURES OF CAST IRON TEST BARS

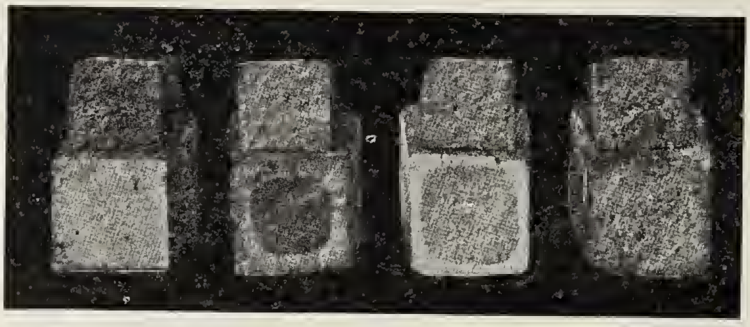

FIG. 2—SOFTENING EFFECTS OF FERROSILICON ADDED TO A LADLE OF MOLTEN METAL

AFTER almost a lifetime spent in the study and daily practical application of investigations in metallurgy on a somewhat large scale, more particularly in cast iron in industrial works, sometimes I feel that I know less about the subject today than I thought I did nearly 40 years ago. This is not surprising, however, for I believe it is the universal experience of investigators that the more they delve into Nature's mysteries the more they find to discover; thus, relatively, the more one studies the less one feels that he knows.

The history of the study of astronomy affords, for example, a striking illustration of this. Long before Galileo pointed the first telescope at the heavens, in 1609, the old monks, with infinite pains, had mapped out the firmament and recorded the positions of all the stars then visible to the eye of man and they naturally thought that their charts were complete. But the moment the new and more powerful eye of the telescope was pointed at the blue vault, hundreds of thousands of starry worlds came into view whose existence had never before been suspected, revealing glowing stars so far distant that the light from them must have started on its long journey centuries before the Christian era. So it is with more mundane affairs, such as the study of the composition and physical properties of metals and alloys. Chemistry has told us pretty well the elements and proportions of the components of complex alloys like cast iron, but after all, that is a very dim light to guide us and it only reveals a few of the most conspicuous properties, leaving many others yet to be discovered by those who come after us.

In comparatively recent years the microscope has supplemented chemical analysis and has given us much valuable information regarding the effect of heat treatment upon the structure of metals, especially iron and steel. The spectroscope also has shown us the signatures of all metals, written in fine lines of colored lights that cannot be imitated or disguised.

The specific gravity of alloys and the remarkable changes in density that may be effected by heat, as in the case of the extraordinary growth of gray cast iron when subjected to repeated heating and cooling* or the equally remarkable change in density caused by sudden cooling from the liquid to the solid state, as shown in the tread or periphery of a chilled cast iron car wheel, are subjects of great interest for study. These are but a few of the aids to the study of metals now available and a vast unexplored field yet remains for the future investigator.

The difference between wrought iron, steel and cast iron, commonly is attributed mainly to the proportion of carbon, silicon, sulphur, phosphorus and manganese, together with a few other elements composing these alloys, and the analytical chemist has no difficulty in determining the relative proportions of these elements with sufficient accuracy; but beyond this lies a region of which he knows nothing. He does tell us, it is true, that carbon exists in iron in two different forms, combined and graphitic, but how many other forms of carbon may there be united with these other elements? We already know of three totally different forms of pure carbon, as follows: A soft, intensely black substance called lamp black which the chemist tells us is 100 per cent carbon; an intensely hard, transparent crystal, the diamond, also 100 per cent carbon and pure plumbago or graphite, an unctuous material, quite different from the other forms, also 100 per cent carbon. There is absolutely no chemical difference between them.

In like manner it is known that pure silicon exists in three distinct forms or amorphous conditions. So it is with some and probably all of the other elements combined with iron.

The chemist or physicist is not yet born who, by any known methods of investigation, can state positively or even guess at the various possible forms or combinations of the elements composing these alloys and, therefore, it is not surprising that frequently the analyses of two specimens of iron, steel or other metals will be nearly alike when the physical properties are different. These are a few of the problems that I have been

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Presented at the June meeting of the Philadelphia Foundrymen's association. The author is metallurgist of Wm. Sellers & Co., Inc., Philadelphia.

*Two bars of gray cast iron were displayed by Mr. Outerbridge, that were cast in one mold from one ladle and were both originally the same size, namely, 14 13/16 x 1 x 1 inches. The specific gravity of the metal was 7.21, making 450 pounds to the cubic foot. One bar had been permanently expanded or caused to grow while in the solid form to 16½ x 1⅛ x 1⅛ inches, making an increase of 40.97 per cent. The specific gravity of the expanded bar is 5.54, making 350 pounds to the cubic foot. Other bars of gray cast iron have been caused to increase in cubical dimensions over 50 per cent by repeated heating and cooling, still retaining their metallic qualities.

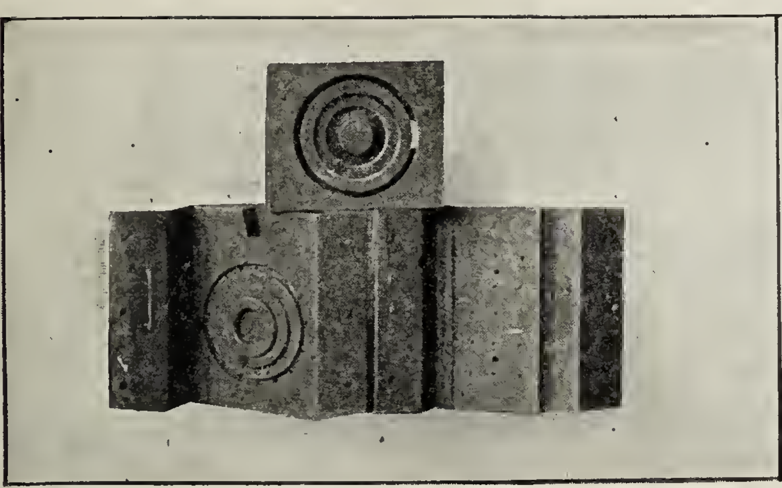


FIG. 3—AN IRON MOLD MADE IN 1903 AND THE CASTING IT PRODUCED

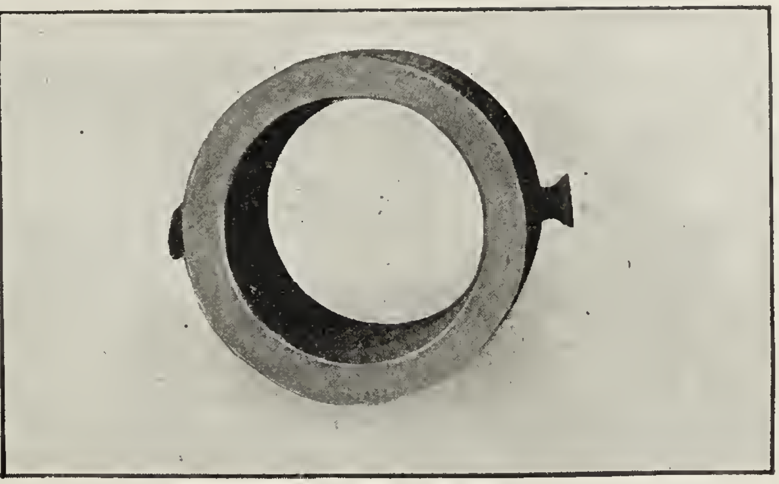


FIG. 4—IRON MOLD FOR A BUSHING OF A 42-INCH CAR WHEEL LATHE

studying for a period of nearly 40 years.

A number of cast iron test pieces made to illustrate an address which I delivered before the Franklin Institute in 1888 on "The Relation Between the Physical Properties and Chemical Constituents of Pig Iron" are shown in Fig. 1. These test pieces were cast from eight different melts of iron. The two upper rows were poured in green sand molds having an iron chill block on one face.

The test bar at the right hand upper corner shows merely a skin chill on the part cast against the iron block; the next bar displays a little more chill and the other bars show increasing proportion of white iron on the upper faces and two show white iron on the lower faces also. Underneath the eight test pieces cast in sand, are nine square and four round test pieces, all *white iron,* showing very clearly that the crystals are always formed at right angles to the surface of the mold. These test pieces were cast in *iron molds* from the same ladles of iron as the other bars and it will be noted that all are equally white, notwithstanding the fact that the bars cast in sand with an iron chill block on one face vary enormously in depth of chill.

These iron molds may be called *chill magnifiers.* I have used similar chill cups daily for detecting chilling properties in soft foundry irons for over 30 years, and they have proved to be of the greatest value in detecting chill that would not otherwise be suspected in such iron mixtures.

The main difference in composition of the eight melts of iron shown in Fig. 1 was found to be in the relative proportions of silicon. The test piece showing a mere trace of chill has over 1.5 per cent silicon; the one showing the most chill has about 0.60 per cent silicon and the other test pieces contain silicon ranging between these extremes.

Charcoal Irons Make Car Wheels Possible

The manufacture of chilled cast iron car wheels, a purely American invention, to which the development of railways in this country may be said to owe their rapid progress in the early days and to which they are still largely indebted for freight traffic, was rendered possible by the practical application of the chilling property found in our cold blast charcoal irons, and its continued success today is dependent largely upon the skill of the chemist to simulate those natural qualities by other means, long after cold blast charcoal iron has gone out of existence.

My first investigation of this peculiar property of cold blast charcoal iron (and of some grades of anthracite and coke iron) dates back to 1876, when a fine exhibit of chilled cast iron car wheels at the Centennial exhibition first attracted my attention. One of the wheels was broken to show the fracture; the plate and brackets were dark gray, while the tread of the wheel was as white as silver. I learned that the white iron tread was formed by the sudden cooling of the metal cast against a heavy iron chill ring and that while the plate and hub of the wheel were quite soft, the tread was hard as steel.

At that time I was making some specific gravity determinations of various metals in the assay laboratory of the mint, where I was an assistant, and samples of the white iron forming the tread of a wheel and of the dark gray iron forming the body were furnished to me for examination. I was astonished to find that the white metal weighed about 60 pounds to the cubic foot more than the gray iron portion of the same casting. This served to explain the abnormal cooling strains in a chilled casting of this character, necessitating prolonged annealing, or very slow cooling, to enable the molecules to adjust themselves gradually, relieving the strain.

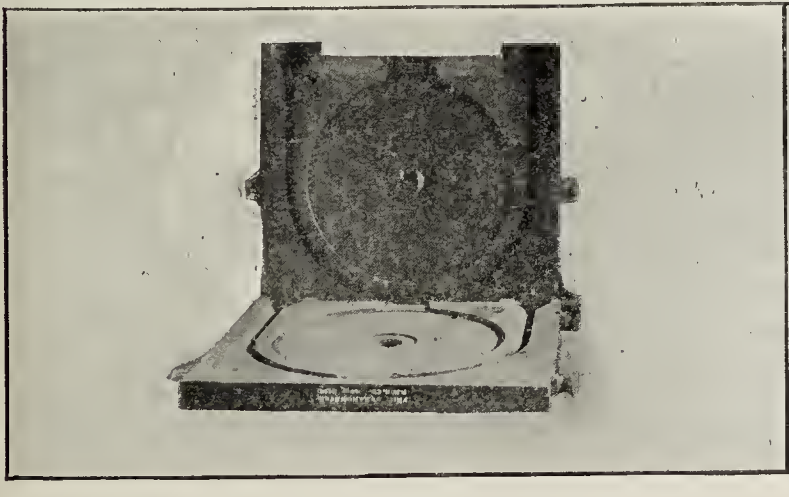


FIG. 5—AN IRON MOLD FOR A FRICTION DISC

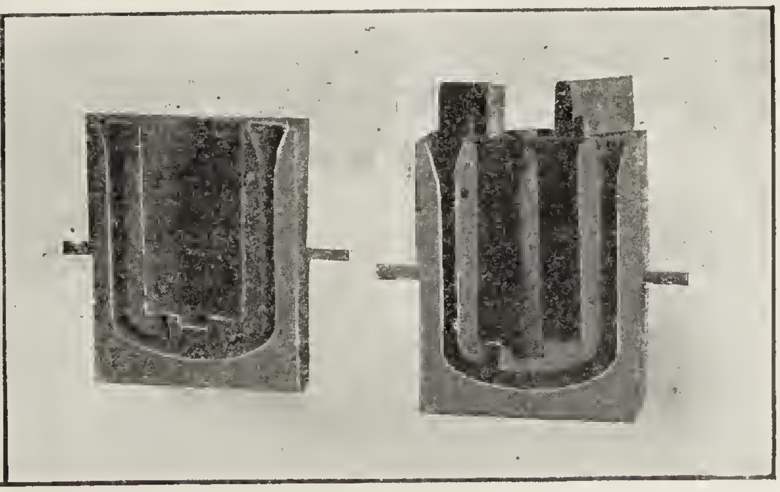


FIG. 6—IRON MOLD AND CORE FOR A SPIRAL PINION

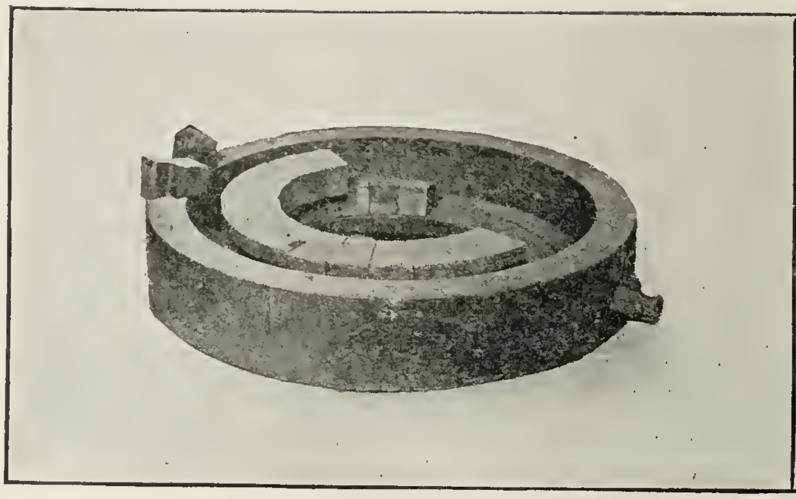


FIG. 7—IRON MOLD WITH A COLLAPSIBLE CENTRAL PORTION

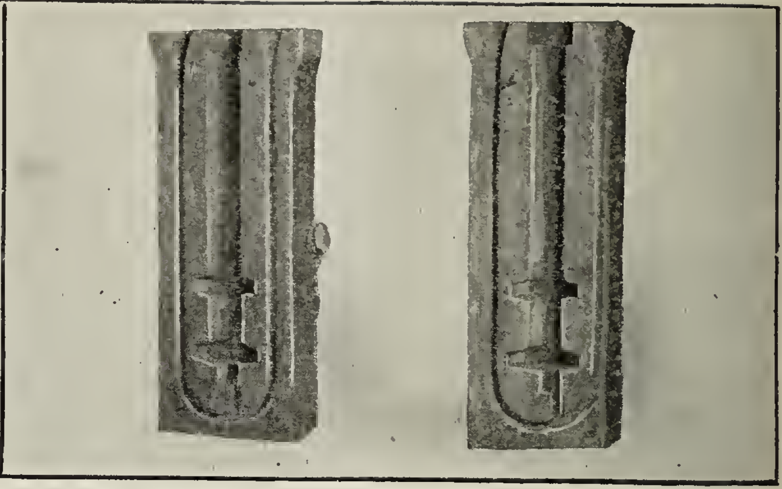


FIG. 8—IRON MOLD FOR SPINDLE OF A HORIZONTAL DRILL

These investigations led to others, and for a period of eight years I was daily engaged in the study of the metallurgy of chilled cast iron car wheels and their manufacture. It was customary to cast each day in the car-wheel works where I was engaged as metallurgist a large variety of chilled car wheels ranging from full size, double-plate passenger and freight wheels, 33 inches diameter, street car wheels (usually of spoke pattern), down to small and light mine car wheels.

It was not possible to pour all of these from one mixture of iron, since the metal suitable for the heavy wheels was too high chilling for the smaller wheels. This necessitated melting soft iron every day in a separate cupola to mix in varying proportions with the regular iron in separate ladles.

To overcome this expense, if possible, by altering the character of the iron in individual ladles, after delivery from the cupola, a great many experiments were made (1880-4) with aluminum costing $8 per pound, spiegeleisen and 80 per cent ferromanganese, granulated or powdered, added in small quantity to the metal in the ladles.

The effects produced by aluminum and spiegeleisen were in the right direction though they were not sufficiently marked to be valuable, but it was then found that when powdered 80 per cent ferromanganese was added in the proportion of one pound to 600 pounds of iron, a most remarkable change was immediately produced in the character of the molten iron in the ladle. The first publication of these experiments was made in the address already alluded to, printed in the Journal of the Franklin Institute, March, 1888, and was as follows:

> A remarkable effect is produced upon the character of hard iron (i. e., high chilling iron) by adding to the molten metal, a moment before pouring it into a mold, a very small quantity of powdered 80 per cent ferromanganese, say one pound in 600 pounds of iron. The result of several hundred carefully conducted experiments which I have made, enables me to say that the transverse strength of the metal is increased from 30 to 40 per cent, the shrinkage is decreased from 20 to 30 per cent and the depth of the chill is decreased about 25 per cent, while one-half of the combined carbon is changed into free carbon.

Prior to this time, manganese always had been regarded as a hardening element in cast iron and the surprising claim that when added in a ladle of high chilling car wheel iron it had an opposite effect at first met with incredulity, but in course of time its use became almost universal, and I believe it still is used very largely in the manufacture of chilled cast iron car wheels. No application for patent rights was made for this process.

Ferromanganese, when added in powdered form to a ladle of molten car wheel iron acts as a deoxidizing and desulphurizing flux by reason of the strong affinity of manganese for oxygen and sulphur, but it is only efficacious when added to iron that is comparatively low in silicon, less than 1 per cent, and high in combined carbon.

It is absolutely useless, if not positively harmful, when added to foundry mixtures carrying over 1 per cent silicon and but little combined carbon, yet I know that 80 per cent ferromanganese has been sold to foundrymen for the treatment of their foundry iron mixtures during the time when the alloy could be bought for a few cents a pound. Its present price is prohibitive, except for special purposes.

The use of ferromanganese as a flux in ladles in car wheel manufacture is of enormous value to that indus-

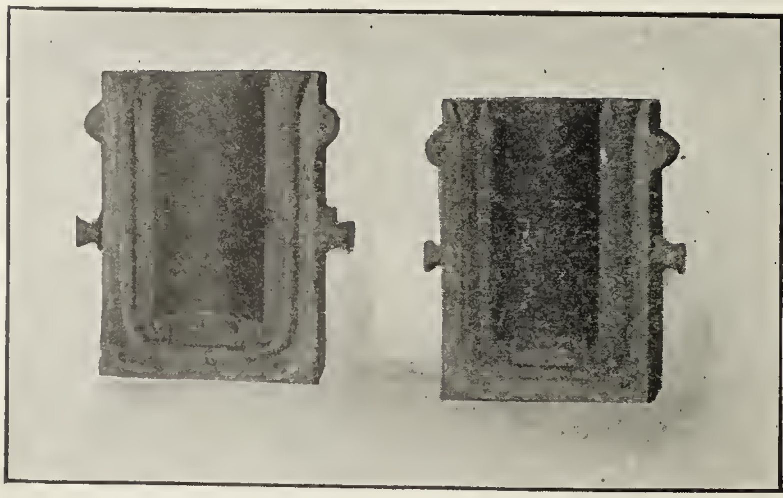


FIG. 9—IRON MOLD FOR A SPIRAL PINION OF A 174-INCH PLANING MACHINE

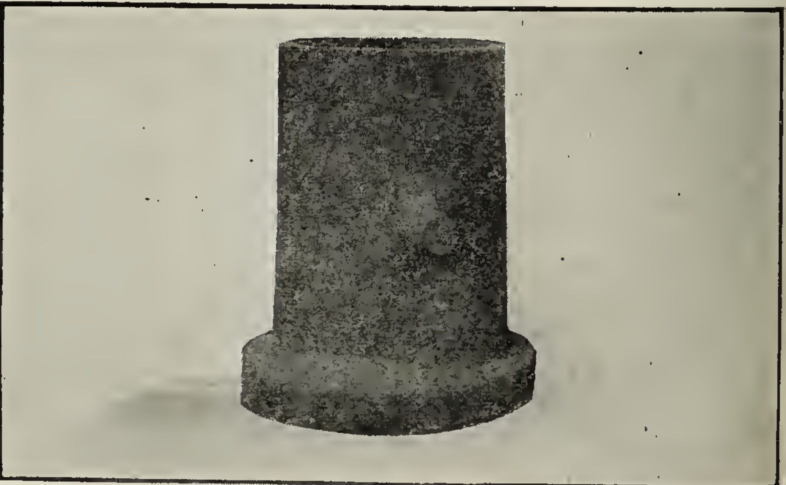


FIG. 10—AN IRON MOLD FOR A FLANGED BUSHING

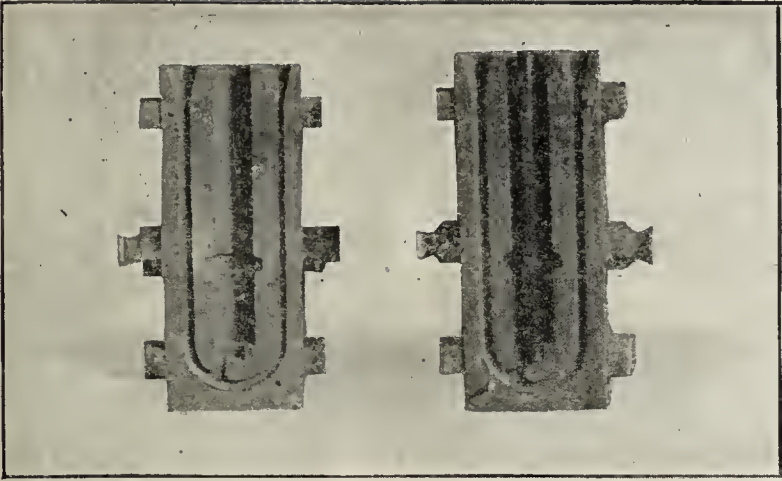


FIG. 11—AN IRON MOLD FOR A SPINDLE OF A RADIAL DRILL

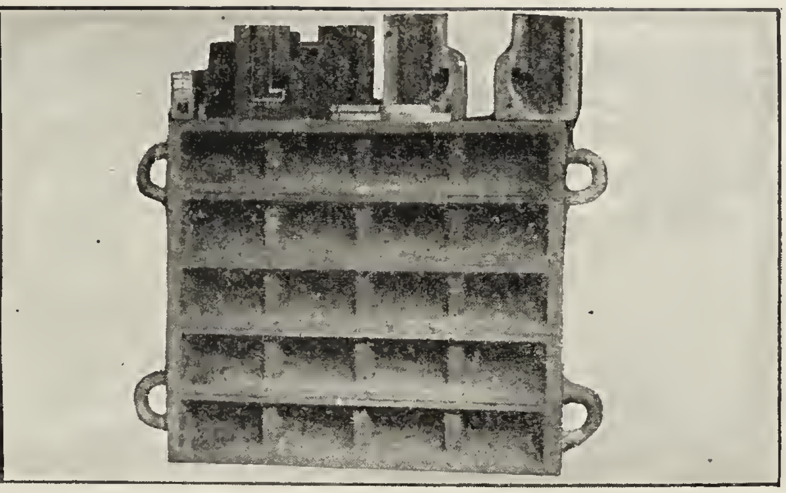


FIG. 12—AN IRON MOLD FOR OVER-PIG

try; its abuse through ignorance or failure to understand its proper functions must have led to disappointment when added as a flux in ladles of foundry iron by those who do not understand or appreciate the radical difference between car wheel iron and foundry iron, whether soft or hard.

While the manufacture of chilled cast iron car wheels requires very accurate control of the chilling property of the metal, it is of far more uniform character than the iron needed for the great variety of castings, ranging from a few pounds up to perhaps 30 tons or over, that must be melted often in one day in the large machine tool works with which I am connected as metallurgist. It is customary, therefore, to group all the small work needing soft, ductile iron so that it will be cast near the beginning of the run of iron from the cupola; this is followed by a medium grade of iron for miscellaneous castings capable of being machined readily, but not too soft to give good wearing service; this again is followed by strong iron mixtures intended for large and heavy work requiring metal of high tensile and transverse strength.

The importance of having some simple, cheap and reliable method of changing the physical properties of molten iron after it has been tapped from the cupola has been regarded as advantageous ever since the value of the method of modifying the chilling property of car wheel iron in individual ladles, by treatment with powdered ferromanganese, became well known. This led to the improper use of ferromanganese in ladles of foundry iron through ignorance of its proper functions.

As long ago as 1880 I made efforts in this direction with alloys of iron and silicon, but at that time the richest alloy obtainable contained less than 20 per cent silicon.

Use of Ferrosilicon

In later years 50 per cent ferrosilicon was produced in electric furnaces for use in steelmaking and these tests were then renewed with the results that have been already published, showing that the addition of a small quantity of the powdered 50 per cent ferrosilicon alloy in a ladle of molten foundry iron produces a remarkable effect upon it, by *softening* and at the same time *strengthening* the iron. This is quite an opposite effect to that produced by increasing silicon in the cupola, which always tends to weaken iron. The accompanying table shows the results of a few tests of this kind made in 1905 with ordinary foundry irons.

The effect of adding four ounces of powdered, 50 per cent ferro-silicon in a hand ladle holding about 25 pounds of molten iron, and of adding one pound to 200 pounds of iron in a ladle, upon the strength and deflection, as compared with the same iron untreated, is clearly indicated in this table.

The success of these initial tests led to more extended investigations. Fig. 2 shows the remarkable effect in reducing chill in foundry iron by adding thereto powdered 50 per cent ferrosilicon in different proportions in the ladle, ranging from 0.30 to 0.80 per cent of silicon. In Fig. 2, No. 1 shows the fracture of two test bars cast from a ladle of untreated iron. The upper piece was cast in green sand, 1 x 1 x 15 inches, and was an ordinary transverse test bar. The lower piece was cast in a heavy iron cup to cool the metal rapidly. The upper test piece is gray and is easy to drill. The lower one is perfectly white and cannot be drilled with an ordinary steel drill. No. 2 shows the fracture of two similar test bars poured from the same iron after the

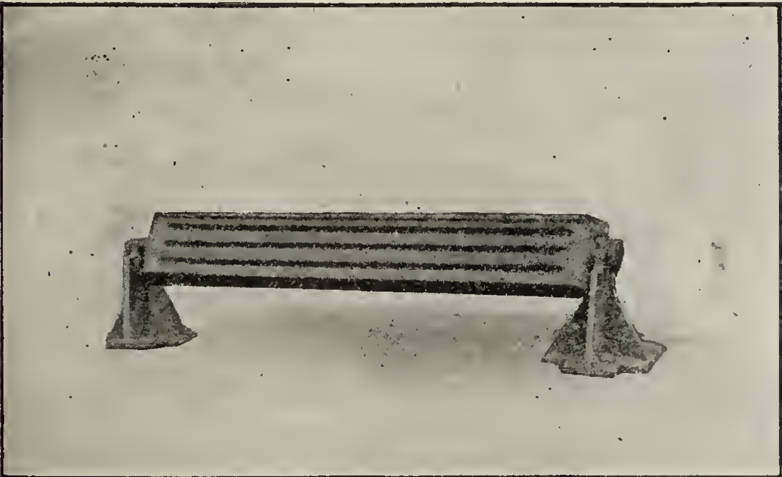


FIG. 13—IRON MOLD FOR CASTING LONG CORE RODS

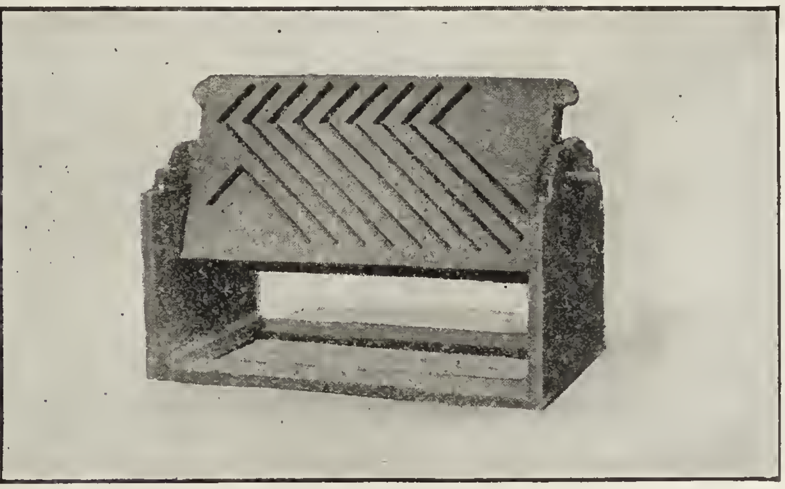


FIG. 14—CAST IRON MOLD FOR CASTING GAGGERS

Results of Tests Following the use of Ferrosilicon in the Ladle

Date	Amount of silicon used	Breaking strains, pounds	Deflection, inches	Resilience	Shrinkage inches	Per cent gain Breaking strain, per cent	Per cent gain Deflection, per cent	Per cent gain Resilience, per cent
Oct. 10, 1905	¼-pound in	2205	0.120	45.30	0.192			
	hand ladle	2155	0.112	40.09	0.191			
	Gain	110	0.008	5.21	.....	5.10	7.14	13.00
Oct. 11, 1905	¼-pound in	2215	0.137	50.51	0.182			
	hand ladle	2165	0.124	44.60	0.185			
	Gain	50	0.013	5.91	.....	2.30	10.40	13.20
Oct. 14, 1905	¼-pound in	2600	0.152	65.79	0.196			
	hand ladle	2055	0.116	39.18	0.188			
	Gain	545	0.086	26.61	.....	26.50	31.00	67.00
Oct. 15, 1905	¼-pound in	2330	0.143	55.45	0.183			
	hand ladle	1893	0.110	34.00	0.183			
	Gain	437	0.033	20.85	.....	23.8	30.00	60.2
Oct. 16, 1905	¼-pound in	2210	0.124	45.54	0.183			
	hand ladle	2120	0.112	39.44	0.185			
	Gain	90	0.012	6.10	.....	4.20	10.70	15.40
Nov. 13, 1905	1 pound in a	2370	0.139	54.76	0.186			
	200-pound	2050	0.118	40.19	0.184			
	ladle Gain	320	0.021	14.57	.....	15.60	17.80	36.20
Nov. 21, 1905	1 pound in a	2178	0.128	46.34	0.188			
	200-pound	2000	0.119	39.60	0.182			
	ladle Gain	178	0.009	6.74	.....	8.90	7.50	17.00

addition of 0.3 per cent of silicon in the form of 50 per cent ferrosilicon added in the ladle. Note the marked reduction in depth of chill in the sample cast in the iron cup. No. 3 shows the fracture of two similar test pieces from the same iron after adding 0.5 per cent silicon in the ladle. The chill is still further reduced. No. 4 shows the fracture of two similar bars from the same iron after adding 0.8 per cent silicon in the same manner. The chill in the sample cast in the iron cup is almost entirely absent.

The samples cast in sand are all gray, but there is an appreciable difference in the fracture, the treated metal showing softer iron than the untreated sample.

Metal Selected for Test

The metal selected for this particular test was comparatively low in silicon, consequently having comparatively high chilling property, but this fact would never be suspected from an examination of the fracture of the test sample cast in sand. Very few practical founders are aware of the large variation in chilling property of their iron, sometimes of presumably similar grades, melted on different days, or even of the wide variations which may occur in different portions of one heat.

In "The Metallurgy of Steel", by Henry M. Howe, the author refers to silicon as follows:

> Iron absorbs silicon greedily, uniting with it in all proportions at least up to 30 per cent and apparently the more readily the higher the temperature, absorbing it even at a red heat when embedded in sand and charcoal. It diminishes the power of iron to combine with carbon....thus favoring the formation of graphite during slow cooling. It increases the fusibility and fluidity of iron; it lessens the formation of blow holes; by reducing iron oxide it apparently removes one cause of red shortness; it hinders at high temperatures the oxidation of iron and probably of the elements combined with it.

Here we have, I think, a practical solution of one great difficulty that heretofore has militated against the successful use of permanent iron molds for making castings that must be machined.

Skin Chill

A mere skin chill, not thicker than a piece of tissue paper, makes the surface of a casting too hard to machine, but by this simple process of adding a small quantity of 50 per cent ferrosilicon in the ladle, the foundry foreman can eliminate the last trace of chill from his metal before pouring it into an iron mold.

For years more or less encouraging efforts have been made and described in technical journals of methods for making castings in permanent iron molds. The most ambitious one, perhaps, was the pipe casting process of Edgar Allen Custer at Tacony, Pa., a few years ago, for which he obtained several patents. Mr. Custer ingeniously overcame the trouble from skin chill on his castings by turning them out of the molds before the molecules had taken a final set and the intense heat in the body of the castings helped to anneal-out any skin chill that might have formed. Mr. Custer failed, unfortunately, to take into due consideration the fact that gray cast iron, of which his molds were made, grows or increases in cubical dimensions when repeatedly heated above a certain point and then cooled.

Early Use of Permanent Molds

Since 1888, machinable castings have been made in the foundry of William Sellers & Co., Inc., in permanent iron molds and still are being so made. Through the courtesy of the president of that company I am now permitted to display illustrations of the original iron molds, still in use, together with some machinable castings that were made in them years ago. Also large and small molds of more recent manufacture. In fact, more than 100 permanent iron molds, ranging in weight from a few pounds up to 7000 pounds each, are in use in this foundry.

The main object of casting in iron molds is to secure machinable castings of exceedingly fine grain, free from dirt, sponginess or other defects, while at the same time having marked increase in strength.

The question of relative cost of castings made in permanent iron molds, eliminating the molder entirely, as compared with similar castings made in green sand, or in baked sand molds, depends upon the number of machinable castings required to be made from one pattern as well as upon other conditions.

An all-iron mold made in 1903 for a saddle for 36-inch planing machine,

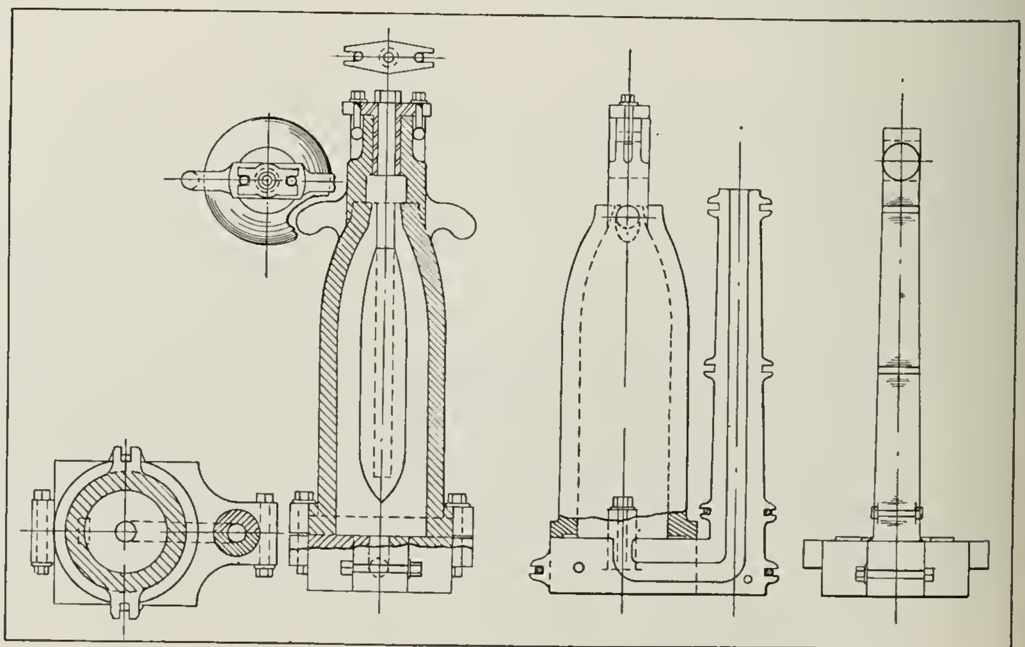


FIG. 15—AN IRON MOLD 30 INCHES LONG, FOR CASTING 10-INCH PROJECTILES

also one of the gray iron machinable castings, absolutely free from any skin chill, made in this mold, are illustrated in Fig. 3.

This was a difficult casting to obtain free from surface defects on one or the other face, or from draw holes, when made in sand, but when cast in this iron mold, they were perfect, and all the saddles subsequently produced, until a change was made in design, were cast in this iron mold.

This mold was made 15 years after my first iron mold was constructed and used in the foundry of William Sellers & Co., and 23 years after the first iron mold was made by me for casting *over-iron* in another foundry, and thereby hangs an amusing tale.

An Amusing Incident

In 1880 I suggested to the foreman of the car wheel foundry of A. Whitney & Sons, Philadelphia, with which I had become connected as metallurgist, the idea of casting all the *over-iron* in iron molds instead of in open sand molds, thus giving more room on the foundry floor and thereby avoiding the expense of making-up a sand pig bed daily.

The foreman exclaimed in alarm, "Why, it will be all *white* iron and when we remelt it with the wheel mixture the next day the wheels will all be too hard. We do use a little white iron sometimes to bring up the chill when the mixture is running down in chill, but this plan would spoil all our calculations."

Nothing but an actual demonstration would convince the man of his error. Iron pig molds were then ordered to be made and a ton of regular wheel iron cast therein. This iron, of course, was white. The next day the ton of white iron was remelted in a small cupola without any admixture and cast into test bars, chill test pieces and two test wheels. On the following day, when all of these were broken, instead of being white iron, as the foreman had predicted, there was no appreciable difference between the castings made from iron that had been chilled white in the iron molds and similar castings made from the same iron cast in sand molds. The result was that no sand pig bed was ever made in that foundry as long as the works continued in existence.

When I became connected with William Sellers & Co., Inc., in March, 1888, I found the same conditions and immediately substituted iron pig molds which have been used daily ever since that time.

These iron molds, for over-iron, anticipated by many years the machine-cast pig iron process now so generally used, and naturally led to the next step, namely, making permanent iron molds for castings, as soon as it was found practicable to prevent iron poured in them from being too hard to machine readily.

Anticipating the question, "How do you prevent these molds from warping or growing so as to become useless"? I will say there are two distinct methods. The simplest method and the one we adopt is to make but one casting from one melt in one iron mold. In this way the mold never gets red hot so that it does not grow. The second method is to use low silicon iron for the molds, as metal of that character grows far less when repeatedly heated and cooled above a cherry red than soft foundry iron. Finally, castings made of white iron do not expand permanently when heated and cool sufficiently to overcome the original shrinkage of the metal, so that when practicable, permanent iron molds may be made of white iron. The accompanying illustrations show iron molds that have been made and used in the Sellers foundry for making machinable castings.

An iron mold for a bushing of a 42-inch car wheel lathe is shown in Fig. 4. This bushing is 19 inches in diameter, 13½ inches deep and only 1 inch thick. The mold is 6½ inches thick and it has a collapsible iron core. The metal must be absolutely free from chill as the thin casting is turned inside and outside.

Large Disc Cast in Iron Molds

Fig. 5 is an iron mold for friction discs for dynamometer for the Pennsylvania railroad; these castings are 42 inches in diameter, are cast 1½ inches thick and are finished all over, ⅞-inch thick. The pull on the draw bar of the locomotive on this machine was originally 80,000 pounds, and was afterwards increased to 100,000 pounds. It was essential that these cast iron discs should be fine-grained and free from the slightest defects. After failing to procure satisfactory castings in sand molds they were cast without flaws in this iron mold. The casting was poured from the bottom.

The iron mold and core for a spiral pinion for a 36-inch planing machine are illustrated in Fig. 6. This has five teeth, 2 inches deep, cut from the solid metal. Semisteel was cast in this mold, free from chill. It was poured from the bottom.

Fig. 7 shows an iron mold with a collapsible central portion. This is the mold for a gear ring for a 42-inch car wheel lathe. Teeth are cut in the ring which is cast solid. The mold is cast open and semisteel is used. Over 100 rings have been cast in this mold. The blank ring is 5 feet in diameter, 8 inches deep and 6 inches thick.

An iron mold for the spindle for a horizontal drill is shown in Fig. 8. This mold is 5 feet long, 21½ inches wide and 18 inches thick. The core is 2½ inches in diameter and the metal of the spindle is 1¼ inches thick. The casting is poured from the bottom.

Fig. 9 is an iron mold, 42 inches long and 28 inches wide, for a spiral pinion of a 174-inch planing machine.

Castings in Permanent Molds

Fig. 10 is an iron mold for a flanged bushing for a 72-inch boring mill. The bushing is 15½ inches in diameter and the metal thickness is ¾ inch.

Fig. 11 is an iron mold for a spindle of a radial drill. The mold is 40 inches long, 16 inches wide and 12½ inches thick. The spindle is 4½ inches in diameter, has a 2-inch core and the metal is 1¼ inches thick. The mold is poured from the bottom.

An iron mold for *over-pig* is shown in Fig. 12. The molds were first made in 1880 and this one has been in daily use for many years. On top of the mold are two iron molds for lifting nuts for the crossheads of large boring mills. These castings must be made of very strong, fine-grained iron. Also on top of the molds are two test bars, originally of the same size, 14 13/16 x 1 x 1 inches cast in the same mold from one ladle of iron. One bar has been caused to *grow* or increase in size to 16½ x 1⅛ x 1⅛ inches, equivalent to 40.98 per cent enlargement.

Fig. 13 is an iron mold for casting long core rods. This has been in use since about 1890. It is so designed that it never warps. Many thousands have been cast in this mold.

A permanent mold of waffle iron design, mounted on trunnions for casting gaggers, is shown in Fig. 14. It has been in use since about 1890. It is so designed that it never warps. Many thousands of gaggers have been cast in this mold.

Fig. 15 is a drawing for an all-iron mold for casting 10-inch projectiles, 30 inches long. The mold was made in 1891. A number of gray iron castings were made in this mold and machined all over. They resembled steel projectiles in appearance. These projectiles were sent to Washington and pronounced the finest cast iron projectiles ever made, but about that time the authorities decided that steel alone should be used; hence, only 14 of these castings were made in this mold.

Electric Furnace as a Copper-Melting Medium

Some of the Advantages and Disadvantages of the Granular-Resistance Type of Electric Furnace in Melting Copper and Its Alloys

By Charles Vickers

THE serene faith of those who contemplate the millenium finds a counterpart in the minds of some brass founders when they think of the electric furnace in connection with the industry to which they have devoted their lives. They realize keenly the defects of existing methods of melting copper and its alloys, and look forward to the day when they will be able to throw in a switch and have their metals melted without contamination by the products of combustion. Therefore, any discussion of the performances of electric furnaces in melting copper alloys is interesting in showing what is being done and in pointing out that the work is going forward, even if not entirely crowned with success.

The subject of this article is a granular-resistance furnace designed and built by the Fitzgerald Laboratories, Inc., Niagara Falls, N. Y., for melting copper and its alloys without departing greatly from the traditions of brass foundry practice. The furnace was designed for the use of crucibles to meet conditions where every heat would be different from its predecessor, and it was imperative that one heat should not contaminate another.

For large metallurgical operations connected with nonferrous alloys it is beginning to be realized that the day of the crucible is passing slowly and, therefore, the present trend in furnace design, electric or otherwise, is to eliminate the crucible by melting the metal in bulk. However, this is not as easy as it might appear, and as the matter is of considerable importance we will digress a little to point out the reason therefor.

A crucible is a wonderful creation; it withstands high temperatures, great pressures and the action of molten metals extremely well. Therefore, it forms an efficient melting vessel for a large majority of the alloys used in brassfounding. This is not the case with a furnace lining which usually is made of siliceous materials, such as bricks, carborundum, etc., and which form chemical compounds with the constituents of some alloys to their great detriment. This is a point that has not received much consideration heretofore, but it is so important that when it comes to be generally recognized that the less silicon contained in the lining of a brass melting furnace the better operating results, a tremendous forward stride will have been made in the application of open-flame furnaces to the melting of copper alloys. In the present state of the art, a noncrucible furnace may be a wonderful success for melting copper-zinc alloys and equally as great a failure in melting phosphor bronze, while no one having only an elementary knowledge of chemistry would ever think of applying it to the melting of aluminum bronze. Therefore, the usefulness of the noncrucible furnace, whether electric, gas or oil-fired, is limited because of the chemical constituents of its lining, and in cases where this is not realized and the furnace is used for melting alloys for which it is unsuited, puzzling difficulties are encountered that ultimately force a resumption of the former practice of crucible melting. Before leaving a subject of such interest and importance to both furnace manufacturer and user, it may be well to mention that the problem of a nonsiliceous lining for brass melting furnaces is not hopeless of solution in view of the present resources in refractory materials.

How the Resistance Furnace Operates

A resistance furnace operates on the same general principle as the incandescent lamp. In the latter the light is produced by the filament because it is too small to carry all the electric current that attempts to crowd through it when the switch is turned on. The result is that the filament is overloaded, heat is generated, the filament becomes incandescent and light is emitted. In the resistance furnace the heating element is a continuous conductor the same as the filament in the lamp. Similar to the filament, it is a poor conductor of electricity, and offers resistance to the passage of the electric current, thereby producing heat. Most electric heating devices are constructed on the resistance principle, and in an elementary form many consist of a helix of iron or nickel-chromium alloy wire which, when loosely coiled around an asbestos-covered length of stove pipe fitted to legs, with the coils arranged in such a manner that they do not touch one another, forms a rather crude, but quite efficient electric heating device. Annealing ovens and muffles are constructed on this principle that will develop temperatures approaching 1000 degrees Cent., or 1832 degrees Fahr. These consist of a suitably shaped, hollow, fireclay tile, wound externally with coiled wire the ends of which are attached to devices designed for electrical connection. The fireclay tile, with its winding of wire, is covered with some good heat insulating material and the whole is enclosed in an iron box to make a neat appearing, rectangular oven. When the proper current is passed through the wire around the tile constituting the oven, it becomes red hot and the heat passes through the walls of the tile and the oven becomes heated to a glowing temperature.

Furnaces constructed on this principle will melt the most refractory of the ordinary metals. Of course, iron or nickel-chromium wire cannot be used for the resistance element as it would melt before the charge. In place of the usual resistance alloys, molybdenum wire has been used and in such furnaces the writer has seen pure iron lie liquid for hours. A molybdenum wire wound furnace, however, is too expensive for commercial use, not only on account of the cost of the heating element, but because it must be protected against the destructive action of oxygen. In the lamp the air is exhausted, similar to the filament of an incandescent lamp, but in the furnace this is not practicable; therefore, the air must be displaced by an inert gas, so that in the case of the molybdenum wire wound furnace it is necessary to continually pass hydrogen through the furnace to envelop the heating element in this gas; otherwise, it would burn or oxidize and would be destroyed.

In a granular resistance furnace, the heating element, as its name implies, is formed of some granular substance such as coke and the resistance of the coke can be varied by the closeness with which it is packed, and by mixing with the raw coke other coke that has been partially graphitized.

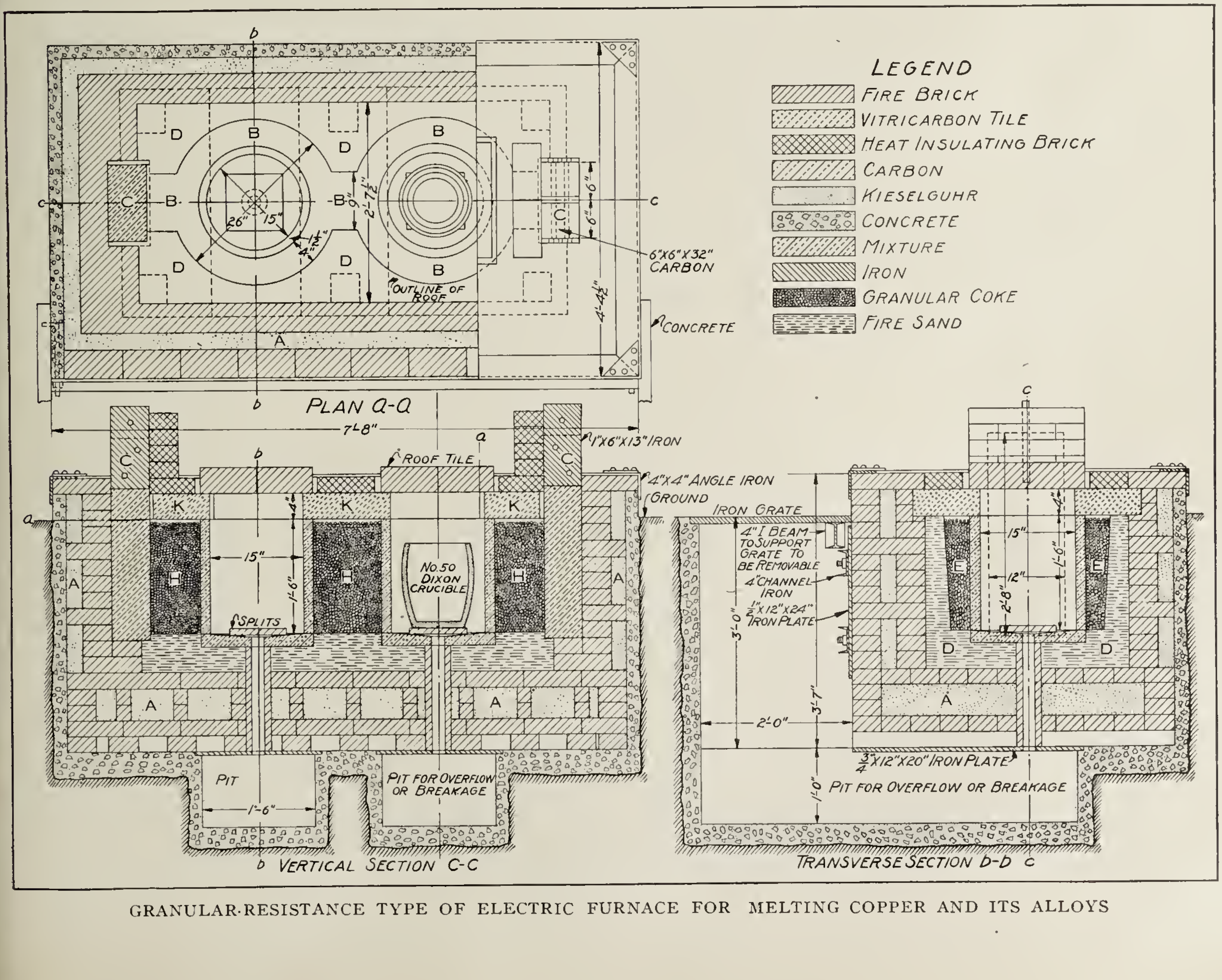
The furnace herewith illustrated was built inside of a rectangular concrete pit in the ground, with a space in front the same as a coke hole. This space, however, was not provided for the removal of ashes, but to give access to the overflow pits directly underneath the melting holes, so that any metal, due to leakage, could be removed therefrom.

The walls of the furnace were built of fire brick and were made double with an air space between each wall. This air space was packed with kieselguhr, as shown at *A*, the object being to conserve the heat as much as possible as a measure of economy. The success with which this end was attained is demonstrated by the fact that after the furnace was shut down the melting holes would remain red hot for 12 hours and would not cool to the shop temperature for two weeks. In this type of electric furnace heat insulation is important, as the source of heat is too costly to permit of loss by radiation. The brickwork formed a rectangular box, the bottom of which was perforated by two openings which communicated with the two overflow pits at the lowest point of the furnace, for draining the metal from the melting holes in the case of crucible breakage.

Results of One Day's Operation of a Granular-Resistance Furnace

Time	Volts	Amperes	Remarks
8:30 a.m.	120	190	
8:45	120	240	
9:00	120	400	
9:15	120	570	Melting holes red
9:32	120	720	
9:41	110	690	
9:44	100	630	
10:00	100	660	
10:12	92	630	
10:30	92	600	
10:40	89	580	Temperature 1200 degrees Cent.
10:42	100	630	
11:00	100	720	
11:05	100	720	A heat of copper charged, 25 lbs.
11:15	100	720	
11:25	100	720	Copper molten.
11:30	100	720	Copper removed and cast.
11:45	100	720	
11:46	90	630	
11:55	90	620	Copper charged, 25 lbs.
12:15 p.m.	90	600	
12:28	90	595	Copper molten and hot enough to pour.
1:00	90	570	Temperature, 1300 degrees, Cent.
1:15	90	590	
1:25	90	610	
1:26	80	520	
2:15	80	480	Charged heat of nickel.
2:40	80	450	
2:50	90	500	
3:35	90	630	
4:00	90	690	Nickel molten, removed and furnace shut-down.

On the bottom of the box a layer of carborundum fire sand several inches deep, was rammed and on top of this the electrodes, *C*, shown in both plan and cross-section, were placed. The electrodes were located at either end of the furnace and consisted of two square pieces of amorphous carbon, 6 x 6 x 32 inches, bolted together. The upper ends of the electrodes were provided with means for the attachment of the terminals through which the electric current was conducted through the furnace. From this point the furnace was constructed like a mold. Hollow, cylindrical wooden patterns, similar in cross-section to *E*, in the transverse section, were bedded centrally on the foundation of fire sand over each drainage hole. The patterns were joined together in the center of the furnace, and were connected at the ends with the electrodes; the patterns thus formed a continuous channel from electrode to electrode, with circular enlargements for the melting holes. The space around the patterns was rammed-up with moist carborundum fire sand to the top of the patterns, thus forming the walls, *D*, shown in the plan, and



GRANULAR-RESISTANCE TYPE OF ELECTRIC FURNACE FOR MELTING COPPER AND ITS ALLOYS the transverse section through *b-b*.

The next operation was to form the walls of the melting holes. This was accomplished by ramming a bottom of carborundum fire sand, suitably bonded, inside of the wooden ring patterns. On this bottom a solid, cylindrical pattern was centrally located, the diameter of which was made smaller than the diameter of the inside of the ring pattern to provide space between the two, equal to the desired thickness of the walls of the melting hole. This annular space then was rammed solid with a moist refractory mixture of carborundum fire sand bonded with clay and silicate of soda. The patterns were then withdrawn and the walls were patched where necessary and were allowed to air-dry.

When the walls had hardened sufficiently, the resistor consisting of small pieces of coke, graded to pass through a ½-inch screen was placed in the channels left by the removal of the patterns, as shown at *H* in the vertical section. A current of low voltage next was turned on, and the furnace was allowed to dry at a gentle heat. When dry, the top of the furnace was covered by tiles of vitricarbon, to retain the heat and to give the furnace a finished appearance. After the furnace was built many improvements suggested themselves, which would have contributed to its more efficient operation. This was natural, however, in view of the fact that probably this was the first furnace of this type to be installed for operation on a commercial scale.

The melting holes were designed to accommodate No. 50 crucibles, but in practice much smaller pots were employed. The construction of the furnace, with the upright electrodes at the ends, interfered with the safe handling of metal in quantities greater than could be handled easily by one man.

Performance of the Furnace

As to the performance of the furnace, little definte information is available. The accompanying table gives the results of one day's run that may be regarded as typical. An alternating current was used, the consumption of power would be the product of the number of amperes and the number of volts, multiplied by the power factor which was not ascertained. It will be noted that the second heat of copper required eight minutes longer to melt than the first; this was due to the fact that the second heat was held a little longer than the first. In a furnace of this type, metal can be held for hours without deterioration, by closing the drainage pit and tightly covering the furnace. The addition of charcoal around the crucible and on top of the metal insures an atmosphere of carbonic dioxide gas in the furnace which is inert so far as molten copper is concerned. The result is that the copper is melted in the absence of oxygen and sulphur, which is the ideal melting condition for this metal and its alloys. When copper, melted under these conditions, was poured into a chill mold, it appeared to be unchanged so far as could be detected by its behavior, and when poured into sand molds, no swelling of the heads occurred. The resulting castings were porous, but the porosity was very slight and could have been prevented by the addition of a minute quantity of any suitable deoxidizer, with the result that castings of the highest electrical conductivity would have been produced.

Enemies of the Brass Founder

The two great enemies of the brass founder are oxygen and sulphur, both of which are soluble in copper and the alloys of copper, and these exist in the atmospheres of all the ordinary furnaces used for melting these metals. When molten copper contains sulphur, the latter oxidizes to sulphur dioxide (SO_2), which is the gas that causes the metal to spit and become spongy during solidification. In a furnace with a melting chamber constructed as in the granular resistance furnace we are considering, there is neither sulphur nor oxygen, if it is properly managed; consequently, many of the difficulties incident to the production of castings of the nonferrous metals are eliminated, resulting in great economy of both time and money.

It is not the contention that an electric furnace of the granular resistance type is the ideal melting medium for brass foundries. It was employed in this instance because its construction adapted itself readily to the attainment of a melting chamber from which the elements injurious to copper could be most easily excluded during the period of melting. Any other type of furnace can be used, provided it will meet the same conditions. For this purpose the electric furnace has the advantage over the combustion furnace, since heat is not produced by chemical reaction. This is the greatest asset of the electric furnace for melting nonferrous alloys and should be taken advantage of whenever furnaces for this purpose are being designed.

The cost of electric melting may be considerably higher than that of fuel melting, and still the advantage will lie with the electric furnace, provided the peculiarities of copper and its alloys are understood and are taken into consideration when the furnace is designed. This is due to the fact that such furnace would act as a preventative of spongy and otherwise defective castings, which, while they might not be spongy, are scrapped because they fail to meet some physical tests that are imposed. Oxidation is the cause of many defective castings which are part metal and part dirt, and consequently are not strong. The trouble with the spongy casting is due to oxygen and sulphur, or to oxygen and any other element that will oxidize to a gas. Both difficulties are the source of serious losses in brassfounding and are avoided only by the most careful attention to melting details aided by the judicious use of costly additions which act as deoxidizers and desulphurizers and which may be regarded as cures.

The reason why the brassfounder adheres so strongly to crucible melting is because he has found by experience that it gives him the best results. This is due to the fact that he practically is melting in a muffle. The crucible protects the metal, to a very large extent, from the furnace gases, especially if the molten surface is kept covered with a fusible, inert flux, mixed with charcoal. Under these conditions, alloys of excellent physical properties can be produced when the necessary skill is available, but only at the price of eternal vigilance. The necessity for skill and vigilance constitutes the weak point, especially in view of present labor conditions. What is required in brass foundry operations is a fool-proof melting device rather than a cheaper melting medium; therefore, in considering the application of electric power to melting nonferrous metals, ultimate results should count for more than cost of operation.

A Simple Furnace Test

There is a great difference between melting copper, brass and bronze, and iron and steel, and because a furnace may prove eminently successful with the latter metals, is no indication that it will be equally successful with nonferrous metals. The value of an electric furnace for melting brass or bronze can be ascertained by a simple experiment. All that is necessary is to melt, or attempt to melt, a heat of ordinary bronze turnings, minus charcoal or other fluxes. If the atmosphere of the furnace is oxidizing, the turnings will weld together to an infusible mass, and very little liquid metal will be produced. Such a furnace would be far from fool-proof, however. In the granular resistance

THE FOUNDRY DATA SHEET, JULY, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

FORMULAS FOR THE BRASS FOUNDRYMAN

A Very Stiff, White Nickel Alloy

For all work requiring a stiff, white alloy that will cast fairly well and buff to a finish resembling nickel-plate, the following alloy will be suitable:

	Per Cent.
Copper	65.00
Nickel	32.25
Aluminum	2.75

Melt the copper and the nickel together under charcoal, or use a flux consisting of fluorspar and lime, in a furnace capable of attaining a very high temperature. An oil or gas-fired furnace is preferable to one fired by coke or coal. When the alloy has reached a dazzling, white temperature, add the aluminum carefully and stir with an iron bar coated with alundum cement, thoroughly dried, and cast in dry sand or skin-dried molds faced with fine silica sand bonded with fine fireclay and molasses water. Pour the metal strongly and provide the castings with generous gating facilities.

Nickel Bronze

Nickel bronze is the name generally applied to any alloy of copper and tin containing nickel. The following alloy is a good example of this class of alloys and finds application as a material for making high-grade gears. The alloy follows:

Copper	85 pounds	11 ounces
15 per cent Phosphor-copper		5 ounces
Nickel	3 pounds	
Tin	11 pounds	

First melt the copper and the nickel together under a cover of charcoal, with a little borax, and when the copper is thoroughly melted and hot, add the phosphor-copper and stir; follow with the tin, stir once more and pour on the warm side.

The Foundry, Data Sheet No. 237, July, 1917.

FORMULAS FOR THE BRASS FOUNDRYMAN

Benedict Nickel

Benedict nickel is most generally used in the form of sheet and tubing by the plumbing trade for lavatory fittings, but at the present there is a considerable demand for this alloy for bullet jackets and many foundrymen are considering the advisability of engaging in its manufacture in the form of bars for rolling. The formula follows:

	Per Cent.
Copper	80.00
Nickel	20.00

In making this alloy, it is advisable to place the nickel in the bottom of the crucible, with the copper on top. About 25 per cent of scrap of the same composition can be used with each charge and may be added with the copper and the nickel. It is good practice to use a *deepener* on top of the crucible to enable all the cold metals comprising the charge to be placed in the furnace at once. This *deepener* is the upper portion of a worn-out crucible and is placed loosely on top of the melting crucible in the capacity of a hopper. In case all the charge cannot be placed in the crucible and deepener, and scrap is used, it is better to reserve some of the copper than the scrap for future addition, as the latter has a higher melting point than the copper.

To protect the metals from oxidation, charcoal is frequently used as a cover, some of which should be added with the cold metals. It is a question, however, whether it is not better to avoid charcoal in connection with copper-nickel alloys, because if carbon is absorbed these alloys do not roll successfully; therefore, some contend that the following flux is more suitable:

	Per Cent.
Unslacked lime	67
Powdered fluorspar	33

Slack the lime to a cream, add the fluorspar, mix thoroughly and dry; use a minimum of one per cent.

Bring the metal to a white heat before removal from the furnace, stir well, and just before pouring, add 0.25 per cent of 30 per cent manganese-copper.

The Foundry, Data Sheet No. 238, July, 1917.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

furnace, turnings can be liquified without loss other than that incident to the combustion of organic matter or the evaporation of water that may be mixed with the turnings. If an electric furnace fails on this test it is no better than a combustion furnace so far as ultimate results are concerned; consequently, if it costs more to operate than the fuel furnace, the latter should be given the preference, not only on account of its lower cost of operation, but because its advantages and disadvantages are a known quantity.

In the operation of the granular resistance furnace it was found that there was no comparison possible between the quality of the metal produced by this furnace and that of metal produced in a combustion furnace. Therefore, the results of experiments on metals taken from such a furnace were misleading as quite different values would be obtained from the combustion furnaces.

As previously stated, when copper was melted, very little oxidation occurred and the slight amount of porosity probably was due to the oxidation of the metal in being transferred to the molds and while being poured into them. The copper was not treated with deoxidizers.

The great advantage of such a furnace is that it permits nonferrous alloys to be melted in a neutral atmosphere, thereby eliminating a long list of difficulties. Its other advantages, such as freedom from ashes, are shared in common with oil and gas-fired furnaces. The metal losses possibly may be less than in the combustion furnaces.

The disadvantages of the granular resistance furnace are well known to all who have had experience with such a furnace and are largely connected with the heating medium which develops hot spots; also, the resistance steadily increases so that each time the furnace is started up cold the voltage must be boosted or the furnace requires longer to heat, so that eventually, always using the same voltage to start with, a time would arrive when the furnace would not attain a melting temperature before the day's work was over. To counteract this, it is necessary to stir up and repack the resistor from time to time before starting the furnace. There is also a great heat loss due to its having to soak through the walls of the melting hole. The core or resistor always is at a much higher temperature than the inside of the melting hole, and sometimes the difference is so great that vapors of silicon may be streaming from the surface of the melting hole wall in contact with the resistor, while the temperature of the melting hole is no more than necessary for the proper melting of copper. The furnace, therefore, is not particularly efficient from a thermal standpoint, and as it is doubtful whether a granular resistance furnace can be improved to any great extent. Some other form should be devised that will incorporate the good features of the form of melting chamber we have described minus the disadvantages outlined.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Utilizing Copper Turnings

We have a lot of copper turnings that are mixed with small gravel from core sand. Can you give us a smelting flux to use when melting these turnings to pour into ingots?

The gravel can be fluxed off by converting it into a glass by the addition of sodium carbonate (soda ash) with about one-third of its bulk of slacked lime. Mix the turnings with their gravel and the soda and lime together, using about one part flux to eight of turnings and melt at a high temperature. If the slag is not sufficiently fluid, add more flux. Fluorspar also is excellent to use for this purpose.

Improper Melting Methods

We are experiencing unusual difficulties from spongy metal and castings containing blow-holes. These sections are designed for heavy rings for generators. The mixture we are using consists of 90 per cent copper, 9 per cent tin, and 1 per cent phosphor-tin.

Your difficulty is due to carelessness in melting, as the amount of deoxidizer added is sufficient to produce good results if the metal is handled properly in the furnace and if it is removed immediately when melted. While the copper is melting, it should be covered with charcoal, broken fine. When the copper is molten, it should lay quiet under the charcoal and must not bubble as if boiling, as otherwise the castings poured will be spongy. We suggest the addition of some suitable flux, as described in the advertising columns of *The Foundry*. These fluxes are valuable in metallurgical operations because they melt and form a coating over the melted metal, which is impervious to the heated furnace gases.

Castings Subjected to Hydrostatic Test

We are making brass castings that are subjected to hydrostatic pressure, but these leak when the pressure reaches 30 to 40 pounds. We are using the following mixture: Copper, 87 per cent; tin, 7 per cent; lead, 1 per cent, and zinc, 5 per cent.

An inspection of the fractured surface of the casting submitted indicates that the cause of the leakage is due to the oxidation of the metal while in the furnace. There is no good reason why an alloy consisting of 7 per cent tin and 5 per cent zinc should not show a perfectly homogeneous fracture and if it does not, it indicates that there is something wrong with the melting process. However, the use of a small percentage of manganese-copper or phosphor-copper should correct this difficulty. The amount used should be less than 1 per cent. The exact proportion can be determined readily by a few trial meltings, in which successively decreasing amounts of either of the deoxidizers mentioned may be used.

The test provides for casting in a sand mold, a bar 1 inch square and 6 inches long, and when cold it should be nicked and broken to permit of an examination of the fracture. A mixed fracture, that is one that appears to include several differently colored alloys, is an indication of the use of too high a percentage of the deoxidizer.

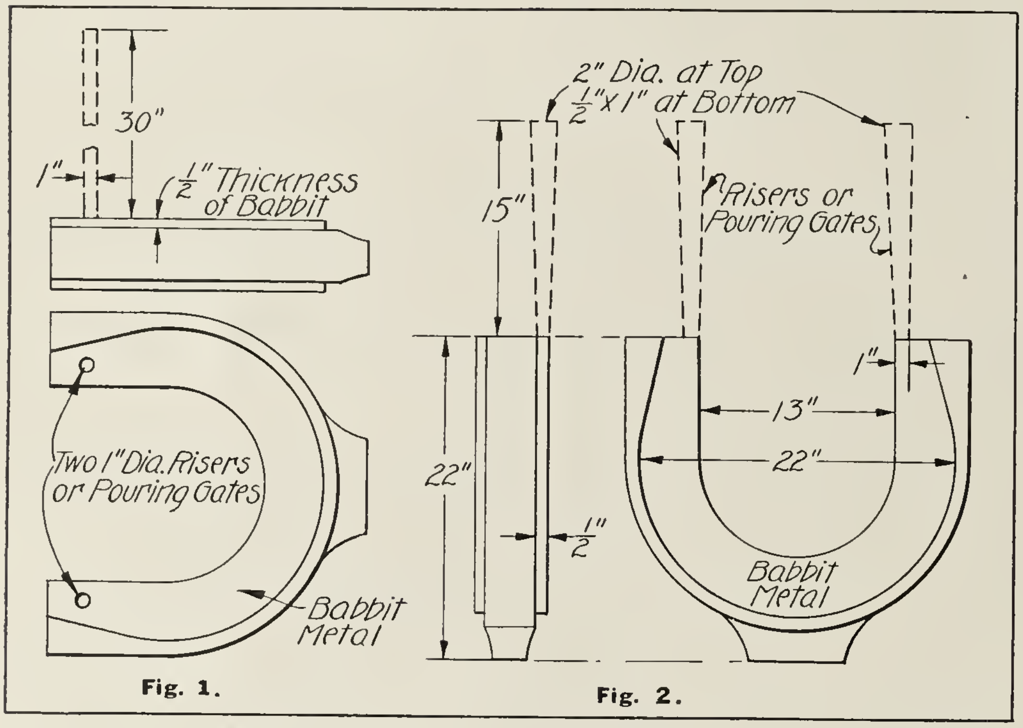
Copper-Plating Aluminum

Kindly let us know whether aluminum can be copper-plated?

Aluminum can be electro-plated with copper, but the process is not practical for commercial purposes. Several methods have been devised by which it is claimed perfect adherent coatings of copper can be successfully electrodeposited upon aluminum, but the adherency of the deposits invariably is of short duration. Aluminum has a great affinity for oxygen and when the most careful treatment is given in the preparation of the surface before electro-deposition, a fine film of aluminum oxide forms, which prevents the perfect cohesion of the basic metal and its deposited coating. By repeated tests it has been found that when aluminum has been plated with an apparently sound adherent coating of copper and has withstood the burnishing test, that eventually, usually within from three to six months, small blisters appear and the deposit is rendered absolutely worthless.

Soldering Aluminum-Bronze Castings

We are making aluminum-bronze castings composed of copper, 90 per cent; aluminum, 10 per cent, and iron, not above 1 per cent. We are experiencing difficulty in soldering the castings. Can you give us the mixture for a solder suitable for this alloy?



METHOD OF BABBITTING THRUST COLLARS

One of the disadvantages of aluminum bronze is the fact that it cannot be soldered. Thus far no solder has been found that will adhere to this alloy regardless of what flux is used. If castings are to be soldered they will have to be copper or nickel-plated. In soldering onto the plated metal care should be exercised to prevent rubbing the soldering iron on the plated surface as this will have a tendency to remove the coating of copper or nickel and it will be difficult to renew the surface again. One of the peculiarities of the tinsmith's business is that the operator always insists on scrubbing or rubbing the tinned surface with the soldering bit. This practice must be discouraged in the case of aluminum-bronze. After the article has been copper-plated, it can be soldered without difficulty by using a solder containing 60 per cent tin and 40 per cent lead.

Method of Babbitting Thrust Collars

What is the best alloy for welding-rods used for electric welding the butt joints of bronze liners on propeller shafts? We have found that the use of copper makes the joints hard and porous. We also would like to know which method of pouring babbitt thrust collars—the one shown in Fig. 1, or that illustrated in Fig. 2, will give the best results and produce good, solid metal. The steel thrust collars will be heated up before babbitt is poured on them. Is it the standard practice to always pour babbitt thrust collars under a 30-inch head of metal, and does that tend to make the metal more solid when the bearing surface is only ½-inch thick?

About the best alloy that can be used in this connection follows: Copper, 90 per cent; 15 per cent; phosphor-copper, 0.75 per cent, and tin, 9.25 per cent.

As far as the babbitt thrust collars are concerned, it will make no difference which way they are cast. The metal will not be any more solid when cast one way, than the other. We fail to see how these parts can be cast by the method shown in Fig. 1 without the use of a very complicated and cumbersome mold, as it is evident the 30-inch pouring gates would have to be sustained by sand or metal. Fig. 2 appears the most practical method of pouring these collars. The use of a head 30 inches high is unnecessary, as it has no influence on the solidity of the metal.

Analyses for Anti-Friction Metal

Recently we analyzed a sample of anti-friction metal, which contained the following: Lead, 55 per cent; antimony, 15 per cent; tin, 22 per cent; aluminum, 3 per cent, and copper, 5 per cent. We tried to duplicate this analysis, but the various ingredients seem to segregate and we would like to know how to overcome this difficulty.

The addition of aluminum to anti-friction metals is not recommended, as it increases the frictional resistance of the alloy and, therefore, it is better to leave it out. Also, if the copper is omitted the alloy will be more fluid and homogeneous. With 15 per cent antimony, the alloy should be sufficiently hard without the use of copper.

One satisfactory anti-friction alloy has the following composition: Lead, 67 per cent; tin, 21 per cent, and antimony, 12 per cent.

Mixtures of Alloys Similar to Duraluminum

We would like to have you furnish us with the formula of the alloy known by the trade name of "Duraluminum".

The following analyses contain the contents of the alloys known as "French" Duraluminum and are fairly typical:

Copper, 2.95 per cent; manganese, 0.81 per cent; iron, 0.55 per cent; silicon, 0.53 per cent and the remainder aluminum.

Copper, 4.05 per cent; manganese, 1.47 per cent; iron, 0.67 per cent; silicon, 0.60 per cent, and the remainder aluminum.

Copper, 3.30 per cent; manganese, 0.19 per cent; iron, 0.29 per cent; silicon, 0.22 per cent; magnesium, 1 per cent and the remainder of the mixture is aluminum.

Difficulties Arising from the Use of Lead

We make bushings and bearings from a mixture consisting of 80 per cent copper, 10 per cent lead and 10 per cent tin, using all new material and melting it in an open-flame furnace. We note that the castings are hard to machine although the metal looks clean. By the use of a magnifying glass, however the machined surface of the castings indicates the presence of many small pores and these wear out the machining tools rapidly. We have noticed that the more lead used in the mixture the greater the resulting difficulties, but in a mixture producing extremely hard brass without the use of lead the machining troubles do not occur.

The addition of lead to certain alloys of copper and tin will cause porosity in the castings under certain conditions of melting and many cases of porosity are due to this cause. In mixing bronze containing lead, add the latter metal last, after cooling the bath to the proper pouring temperature.

Do not add lead to very hot metal and when the percentage of lead is considerable, always use some deoxidizing agent. In the present instance the lead is partially volatilized and fumes attack the furnace lining forming lead silicate which is mixed with the metal and dulls the tools when the castings are being machined.

Probably other compounds of lead are formed which have the same effect. If the metal can be cooled before the lead is added, this is advisable. Also, a flux can be used to advantage; this should consist of plaster of paris with 5 per cent burnt borax and a sufficient amount should be added to form a thin slag over the surface of the molten metal.

This cover will prevent the vaporization of the lead and of the escape of the vapors that attack the lining of the furnace. Every precaution should be taken to avoid the oxidation of the metal while melting, as otherwise, oxide of lead is formed when the lead is added, which immediately attacks the lining of the furnace and results in the production of slags or mattes.

Making Castings for Pianos

We are engaged in the production of castings for pedals and other parts of pianos, but we have been advised that the alloy which we are using is not sufficiently stiff for the purpose of the purchaser. Our mixture consists of 12 parts of copper to 6 parts of zinc, and we would like to know whether the addition of tin would give us the desired qualities. We also find that the castings made from the foregoing mixture shrink excessively and do not run clean although molded entirely in the drag. Can you inform us how to overcome this difficulty?

On a percentage basis your mixture contains 66.67 per cent copper and 33.33 per cent zinc. This alloy is used extensively in rolling mills, but it is a difficult metal to handle in the foundry as it is quite a problem to prevent the zinc oxide from entering the castings as they are poured. We suggest changing the mixture, and if a yellow metal is desired, the following alloy will prove satisfactory: Copper, 70 per cent; zinc, 26 per cent; tin, 2 per cent, and lead, 2 per cent.

We believe that this mixture will prevent dirty castings and also other difficulties due to shrinkage, but no yellow brass mixture will make as desirable castings as red brass. For this reason it might be well to eliminate the yellow brass and substitute the following mixture: Copper, 88 per cent; zinc, 6 per cent; tin, 3.5 per cent, and lead, 2.5 per cent.

Cheap Red Brass Mixtures

We would like to obtain the formulas for several cheap red brass mixtures.

The following alloys generally are classed as cheap red brass alloys:

Copper, 76 pounds; zinc, 10 pounds; lead, 10 pounds, and tin 4 pounds.

Copper, 82½ pounds; zinc, 11 pounds; lead, 5 pounds, and tin, 1½ pounds.

Copper, 83 pounds; zinc, 8½ pounds, and lead 8½ pounds.

White Metal Pattern Alloy

We would like to obtain the formula for a white metal pattern alloy. At present we are remelting our old patterns, but this does not give satisfactory results.

What is generally conceded to be one of the best pattern alloys contains tin, 50 per cent, and zinc, 50 per cent. The alloy is made by first melting the zinc, which is followed by adding the tin.

The old patterns which you are using are liable to contain a large percentage of lead and for this reason it would not be advisable to mix this with the alloy given. To determine this, melt a small amount of the old pattern alloy heat it until red and if zinc fumes do not rise, you can assume the mixture contains a high percentage of lead. This also can be determined by its weight.

Use the following alloy to be mixed with the old pattern alloy, provided it is largely lead: Lead, 80 per cent; tin, 5 per cent, antimony 15 per cent.

Iron and Phosphorus Cause Hardness

Some of the brass castings we are producing are so hard that they turn the edge of our tools and we would like to know the cause of this difficulty. We are of the opinion that the metal is burnt in melting and we would like to know whether this causes the extreme hardness of the castings. The alloy consists of half scrap and half new metal and analyzes approximately as follows: Copper, 82 per cent; zinc, 7.5 per cent; tin, 4.5 per cent; lead, 5 per cent; antimony, 0.34 per cent; iron, 0.85 per cent, phosphorus, 0.01 per cent.

The hardness of the metal is due to the iron in the alloy in connection with the phosphorus contained therein. The latter element is very hard in such an alloy and we assume that hard spots are encountered when the alloy is machined. This is caused by the segregation of the iron, hardened by the phosphorus and tin. The iron cannot be removed in crucibles without taking out the other metal, as it must be eliminated by oxidation and, therefore, the zinc would oxidize first. The cheapest way to use this scrap would be to add more new metal and we suggest the use of 25 per cent of the scrap with 75 per cent of the new metal for the preliminary trial. Probably this mixture might contain too high a percentage of this scrap, but this can only be determined by experiment. Burning the metal will not produce hardness, although in the case of leaded alloys melted in contact with siliceous materials, it will cause the metal to become gritty and difficult to machine on this account. With the alloy given, burning would be productive of spongy castings.

Nomenclature of Aluminum Alloys

We have noted in THE FOUNDRY, *from time to time, reference to alloys such as aluminum No. 12 and No. 31, and again these are indicated as regular brass mixtures. We do not fully understand the meaning of these references.*

The only aluminum alloys that generally are known by number are Nos. 12 and 31. We believe that these alloys were so indicated by the manufacturers of aluminum and were used to designate these alloys when sold in the ingot form. The present practice is to purchase pure aluminum and to make the alloys as required. The formulas for alloys Nos. 12 and 31 were published in the November, 1915, issue of THE FOUNDRY page 461.

Brass mixtures are not generally known by number, as each manufacturer numbers his own alloys to meet his requirements. When gun metal is referred to, it is customary to write it 88-10-2, which means 88 per cent copper, 10 per cent tin and 2 per cent zinc. Another standard alloy is, 80-10-10, and means 80 per cent copper, 10 per cent tin and 10 per cent lead. As a rule, brass and aluminum alloys not only are indicated by numbers, but also the mixture usually is given.

Forgings for Fuse Caps

We are casting bars, 1¼ inches in diameter and 36 inches long, from which we cut slugs for making forgings for fuse caps. Some difficulty is experienced as a result of the flaking of the metal, which we believe is caused by the metal spilling on the lower side of the chill and adhering to it.

This difficulty can be overcome by castings the bars horizontally, but many manufacturers of these forgings have found that the trouble stated by you, combined with the tendency of the bars to pipe, are almost insurmountable obstacles in the production of these fuses from vertically cast bars. It would be a difficult problem to pour the bars so that the metal would not impinge upon the side of the mold and produce spills in a bar of the dimensions stated.

Advantages of Hand and Power Machine Molding

Each Type of Molding Machine is Adapted to a Certain Class of Work—The Author Outlines the Advantages of Each

By R Carrick

WHILE it is generally conceded that founding is the foundation of the engineering industry, and that modern industry depends upon the foundry for a large part of its products, yet it is surprising what a small proportion of the inventive genius that has been busily engaged for generations in the evolution of labor-saving machines has been devoted to foundry machinery. and it is only within comparatively recent years that machine molding has developed much importance as an art.

There is, however, abundant evidence that the deep-rooted prejudice that for a long time existed among foundrymen is gradually passing away. The unprecedented boom in trade, the withdrawal of certain trade union restrictions, coupled with the shortage of labor created by the war, has probably done more than a thousand papers or books could have done, to force the attention of foundrymen to the possibilities for improvement by the introduction of molding machines. One can hardly introduce this question without briefly referring to what we may term the stepping stones to machine, i. e., namely the odd-side, follow-boards and plates. It is surprising to what extent these very elementary means may be employed in improving both the quality of castings and in increasing the output.

The Use of the Joint Board

Probably the first stage in this development was the introduction of the joint-board, namely a flat board with planed face upon which the joint of half pattern, or the face of a flat pattern was laid.

This simple method saved time in ramming and gave a better joint when rolled over, also saving time in joint making. From this it was a very easy step to make a hard part in sand or plaster of paris for shaped joints, and in this way the odd-side came into existence, and with it the necessity for interchangeability in flasks or box parts. Following this came the time-honored match plate with fitted dowels and dowel-holes for the flasks, and carrying a portion of the pattern attached like a medallion. This system of plate molding is very popular in the light casting trade today, and splendid results are obtained both in the quality of castings and in the cost of production.

These early innovations were in themselves a form of machine molding, which could be adopted with every great advantage in many foundries today. The author cannot give with any degree of accuracy the date or even period of the introduction of molding machines in England, but as far back as the year 1800 an English patent was granted for molding screds, the patterns of which were backed out of the sand by lead screws of the same pitch. This was simply a pattern drawing machine of a rather ingenious construction, and so far as we are aware the English patent records do not touch again upon machine molding until 1839 when a very similar patent appeared. Machines for molding gears and pipes also appeared in the first half of the nineteenth century, but it is only within the last 25 or 30 years that molding machines have been used to any great extent in England.

Molding machines, both hand and power, may be classed under four heads. Machines that only ram the mold; machines which draw the pattern; machines that both ram the mold and draw the pattern; and lastly, machines in which every operation is mechanical, including sand-filling, ramming, pattern-drawing and conveying the finished mold away.

The first and second were the most popular machines in what we may term modern machine molding and although they are very simple pieces of mechanism compared with the modern machine tool or high speed engine, they accomplished nearly as great a revolution in the foundry as the latter did in the machine shop. There can be no doubt that in some foundries wonderful results were obtained in both quantity and quality of castings by the aid of these very simple devices. The foundries that adopted them, forged ahead and undoubtedly enjoyed a greater measure of prosperity than those which were content with the methods of hand molding. It is hardly necessary in these times to describe in detail the operation of these simple machines. The hand press or squeezer, as it is more popularly known, is largely used for small light work in iron and brass foundries. It consists simply of a strong table mounted on two stands to which is attached a press-head generally operated by a side lever. A board or hard part is placed on the table, the flask is put in position and filled with sand; the press-head is swung over and the sand is pressed. All other operations are accomplished in the ordinary way. There are hundreds of foundries in England where these machines might be adopted with advantage.

Popularity of Hand Turnover

The hand turnover machine has enjoyed a larger measure of popularity in this country than any other type of machine. The general principle of molding may be briefly described as follows. Plates, boards, plaster blocks or any kind of hard part may be attached to the top side of the revolving table by bolts, clips or screws. Bottom box is placed over it and rammed by hand. It is then clamped to the master part, the table is reversed and the mold left suspended. The lower table is then raised by means of side level until it is pressed firmly against the back of the box. The clamps securing the box to the master part, are released and the platform lowered steadily, the mold descending with it away from the patterns, the top table being rapped with mallet during the drawing process to ensure "free draw." The whole of these operations do not take more than 20 to 30 seconds in the hands of an expert operator. The resulting mold should not require any finishing and if there are no cores to insert, it should be ready to receive top part. It is astonishing what can be saved by these machines. Scores of illustrations may be given where 100, 200 and even 300 per cent has been saved in the cost of labor by taking jobs from the bench or floor and putting them on these machines, the cost of mounting the work sometimes only amounting to a few shillings. The saving in labor has not been the only advantage. There is a greater uniformity in the finished casting, and a much longer life for the pattern. There is scarcely any limit to the work that can be made on these machines, not only plain flat blocks, but very intricate castings that on the floor would require highly skilled molders. Nor are they limited to small work. There are machines of this type working ing in this country making castings weighing over a ton.

Nearly all the power machines on the

From a paper presented at the meeting of the Birmingham branch of the British Foundrymen's Association, Feb. 24, 1917.

market are either hydraulic or compressed air, the latter being most serviceable and popular. The hydraulic machines made by Bonvillian and Ronceray are intended primarily for repetition work. Stripping plates are largely used, the makers having perfected a system of their own for making stripping plates and stools. Only a slight amount of fitters' work is required, however intricate the casting may be. Nearly all the power machines in Continental Europe are hydraulically operated.

The compressed air machines undoubtedly are the most popular power machines. The Americans were the first to adopt compressed air as power for molding machines, and in the United States and Canada these machines have been brought to a very high state of perfection. All classes of castings, ranging in weight from a few ounces to 20 tons, are being made on these machines in that country.

Field of Power Squeezer

The power squeezer is adapted to the same class of work as the hand squeezer, but in the case of the former the machine does the squeezing and consequently the operator is less fatigued and can work faster. Moreover, greater uniformity in pressure can be had with the power squeezer, without putting any undue strain on the man, a point that is worth consideration. The transition from ramming only to both ramming and pattern drawing, is a very easy stage, but marks a great advance. A typical machine of the latter type is the Tabor power squeezing split pattern machine. Machines of this kind are particularly adapted to making molds from symmetrical patterns that can be split through the center or for flat back work. Patterns adapted to this machine are not, however, limited to the two classes mentioned, as any pattern that can be split on a true plane may bet molded on it. With symmetrical patterns but a single plate of patterns is necessary as the cope and drag are molded from a double set of half patterns, the impression of the right-hand set in the drag mating those of the left-hand set in the cope and vice-versa. In operating this machine the half flask is put in position over the pins in the flask frame of the machine and filled with sand. The yoke is then drawn forward and pressure is applied to the mold by pressing down the operating lever until the pressure gage indicates that the sand has been squeezed to the proper density. The yoke is thrown back, the sand is stricked off and the pattern drawing is accomplished by lifting the lever, which also starts the vibrator and raises the mold. The frame automatically drops back to its place immediately after the mold is lifted off. While these machines under ordinary conditions do not require a stripping plate, it is possible to fasten one to the flask frame to insure a perfect draw in the case of very intricate work.

Jar-Ramming Machines

Large work can be handled on jar or jolt-ramming machines. Almost any kind of a mold can be made on these machines, which not only do away with some of the hard labor of the molder, but performs the work more efficiently and in infinitely less time. Although jar-ramming machines are probably the latest development in foundry machines, jar-ramming is in all probability as old as the trade itself. There are few molders who have not in their first apprentice days made small cores by jarring and core-box on the bench to accomplish the ramming.

What is known as the plain jar-ramming machine consists of a huge plunger-base which rests upon a bed of concrete of given dimensions to form an anvil. On this plunger base is a bumper frame which encloses a cylinder and plunger and carries the jolting table. In some machines the bumper frame and jolt table are in one piece. Generally the stroke is of minimum length, and is adjusted to hard or light blows as desired by a back pressure valve, or by a variable stroke, which can be adjusted to the conditions required. It is essentially a sand-packing machine, the packing of the sand resulting from the impact between the table on which the mold is carried and the anvil on which it drops. To avoid unnecessary intensity in the blow struck by the table upon its anvil, a few layers of leather or other non-resilient material are introduced as a cushion. These reduce the wear and noise without_having any material effect upon the action of the machine or sand. A machine of this type can be successfully used for ramming molds for either iron, steel, or brass and will ram any mold in a minute or less. The saving effected by its use on large work is equivalent to the time required to ram the mold by hand. Moreover, the sand is packed as it should be—densest at the surface of the pattern and of decreasing density above. This favors the escape of gases when the mold is poured, and eliminates venting to some extent.

Proper Use of Jar Machines

It is a mistake to try to ram all patterns in this way. Care must always be taken to avoid projections on the pattern which interfere with the proper flow of sand. This sometimes necessitates the use of a core not required for hand ramming, but the patterns when mounted for jarring require fewer repairs and the cost of adaptation of the jarring process is soon recovered. The practice adopted by the author is to have the patterns mounted on a board. If it is a repetition job a proper board forming the joint and following the contour of the patterns is made. If, however, only a few molds are required, an ordinary rough follow-board is used. The board pattern and flask are put on the machine table and filled with sand about 3 or 4 inches above the bottom part, by a laborer. The machine operator then opens the valve and jolts the mold, finishing off with a flat rammer and doing any necessary venting. The mold is then handed over to the floor-molder to be finished and made ready for pouring. In cases where the joint is not formed on the board, the cope is rammed by hand. Where a proper board is used the cope can be jarred like the drag. A machine operator and one laborer, working on a piecework basis can keep a gang of three or four molders finishing the molds.

The shockless jar-ramming machine accomplishes exactly the same work for the molder as the plain machine, but it is claimed that all ground shock is eliminated, Moreover, it is said that only a few inches of concrete is necessary for the foundation as distinct from the plain jar-ramming machine which delivers the entire blow upon the foundation.

Pattern Drawing Devices

Practically the same devices for pattern drawing have been utilized as additions to the jar-ramming, that are used in hand-ramming machines and other power machines. The addition of these drawing mechanisms resulted in giving the foundry a fairly complicated machine like the addition of an automatic lathe to the machine shops, and it can be fairly claimed that they represent to the foundry what the automatic does to the machine shop. While it will be readily admitted that the greatest advantage to be gained from these machines is in highly specialized and repetition work there is, however, a place for them in the average foundry.

Unfortunately many foundry managers and employers in the past have not been as successful with machine molding as they might have been, because having installed the machine they have not given the proper attention to the making of necessary tackle. Very often machines have been condemned, when, with judicious handling they might have become the most valuable asset in the plant. Not only must care and thought be used in selecting the right machines for the work, but equal care and infinitely more thought should be used in making the necessary tackle. Do not infer from this statement that it is always necessary to put down very expensive tackle in order to make the machines a success. One should be guided by the class of work, number required, etc. Many times it will found that the outlay will be very little greater than in plants where floor molding is practiced.

False Arguments Against Machines

One of the most popular arguments against the machine is "Oh! we have not enough repetition work. Our work is always changing and we never get two jobs alike", and so on. But we have generally found that these arguments on the part of the foreman or manager are used as an excuse to save themselves a little trouble and labor, or to cover their prejudice. It is not always necessary to be making work by the hundred or thousand to use the machine successfully. The equipment accompanying a molding machine is usually found in a foundry whether a machine is used or not. The tackle consists of a dozen or two molding boxes that are interchangeable with a couple of planed plates and boards and a few loose runners or gates of different sizes. These are very elementary articles that neither involve any great amount of thought or expense, and may be the means of effecting considerable saving, as well as forming a stepping stone to greater things in machine molding. Of course, as we have previously stated, by far the greatest advantage to be derived by the machine is in repetition work, and there is little doubt that the tendency in the future will be to specialize and consequently there will be a greater scope for machine molding. In such cases where there is that tendency to specialize and where it is known that the work will be made on the molding machine, the foundry manager ought to be consulted before the work leaves the drawing office. Many times alterations can be made that will greatly facilitate the work being made on the machine, without in any way impairing its effectiveness for the work it has to do.

Experiments With Permanent Molds

On page 187 of the May, 1917, number of THE FOUNDRY, an abstract of a paper presented at the Birmingham branch of the British Foundrymen's association was published under the title "Experiments With Permanent Molds". It was stated that J. J. Howell was the author of this paper. This is incorrect, as the article should be credited to E. H. Broughall, of Alfred Herbert, Ltd., Coventry, Eng. The papers by Messrs. Broughall and Howell were presented as part of a discussion of the paper, "The Function of Feeders and Deseners," by J. J. Fletcher.

Pattern Economy in Molding a Fan Pedestal

By John H Eastham

IT IS safe to assume that the pattern storage of every foundry engaged in jobbing work contains one or more patterns used only once and in many cases only a slight variation of design or contour for a casting is responsible for the making of a new pattern which frequently could be avoided. Our shop recently received an order for two fan pedestals of the box type, 30 inches high, sectional and end views being shown in Fig. 1. The exact dimensions of these castings were not determined until most of the companion parts were ready for assembly, when a rough sketch was taken to the foundry with instructions to reduce the time and cost of production. As the base of the pedestal was of secondary importance, provided the head or bearing flange of the small end of the casting was of the correct dimensions, advantage was taken of this latitude to press into service an existing pattern, 5 feet long. When making the mold the following method was followed: At the correct distance from the small end of the pattern, machining and contraction having been allowed for, a new base flange was screwed into place on three sides, the piece carried in the cope having been doweled in the usual way, as indicated in Fig. 2. The pattern next was placed on a face board. The drag half of the flask was lowered over it and a stop-off bar or false end was built into the box 15 inches from the flange. Conical chaplet blocks with brick reinforcement were placed at four points on the pattern body. The drag half then was rammed and rolled over, the parting was made and the runner, riser and vent plugs were placed in position. Fig. 3 shows a cross-section of the mold at this stage. The cope was then rammed with ⅝-inch chaplet bars in their proper positions. The cope next was lifted off, the pattern drawn and the stop-off flange, Fig. 4, with core print attached, was lowered into place, sand having been rammed underneath and around the core print, this procedure being similar to that pursued in ordinary jobbing pipe foundry practice. The stop-off block next was drawn out, the mold finished and blackened, ¾-inch chaplets were placed on conical studs in the drag and the core was lowered into position. A skeleton

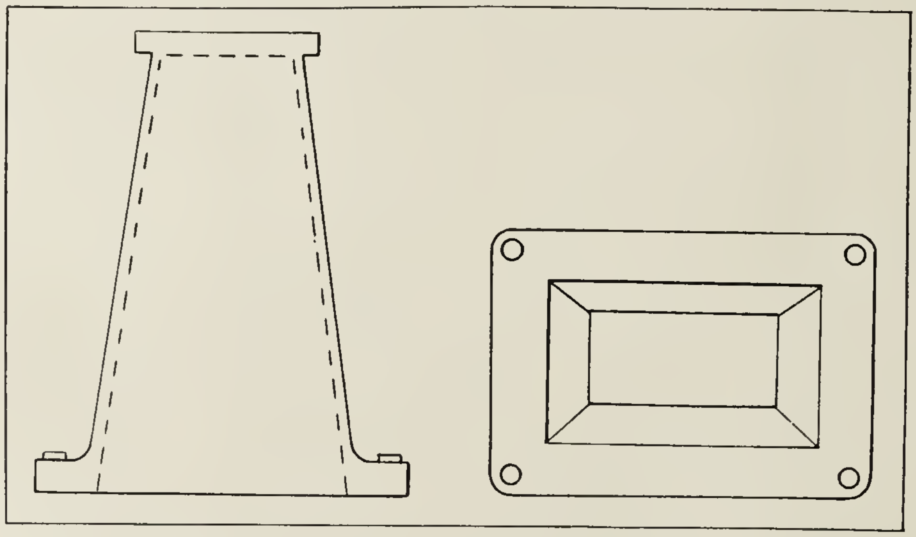


FIG. 1—SECTIONAL AND END VIEWS OF PEDESTAL CASTING

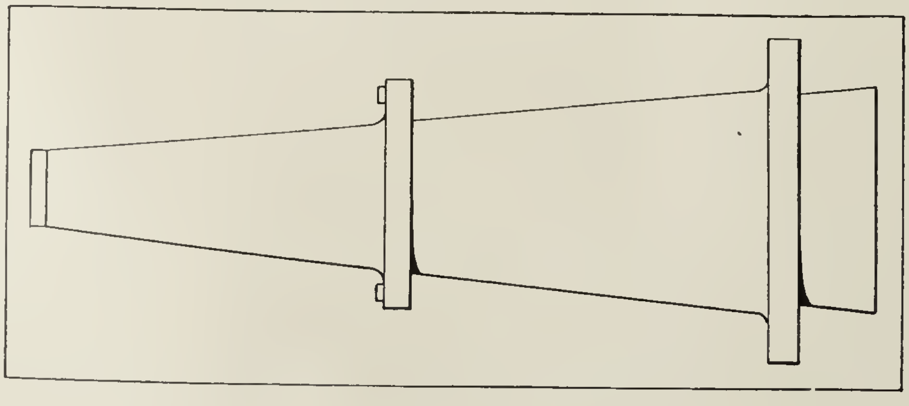


FIG. 2—METHOD OF ATTACHING BASE FLANGE TO THE PATTERN

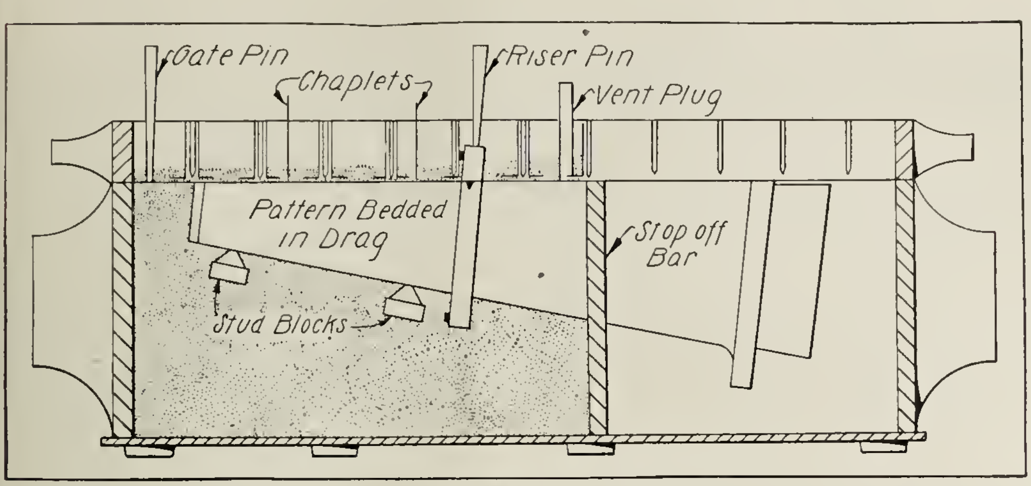


FIG. 3—CROSS-SECTION OF THE MOLD AT THE INTERMEDIATE STAGE OF ITS PRODUCTION

type frame of core box is employed with the stop-off piece attached to it to suit the casting and an additional 5-inch print length, a cast iron arbor having been used. The cope vent was carried out through the open end of the casting, as indicated in the cross-section of the finished mold, Fig. 5.

After the casting was made all charges were carefully checked and due allowance was made for overhead at ½ cent per pound. In this instance the overhead cost is lower than ½ cent. The cost of the castings made in this way, each weighing 295 pounds, was 2.03 cents per pound.

How to Make Chilled Cast Iron Balls

By W. J. Keep

Question:—Can you tell me how to make chilled cast iron balls, from 1 to 4 inches in diameter?

Answer:—I have never had much success in making chilled balls, even as small as 1 inch in diameter. Therefore, I consulted F. W. Seeman of the Lakeside foundry, Detroit, who says that it is very difficult to make castings of this kind. Whether they are gated on top, on the side or on the bottom, the metal will sink on the surface, sometimes at one point and sometimes at another with relation to the location of the gate. By gating on the side and by placing a riser on top and allowing the iron to flow through and out of the riser for a short time, a surface without imperfections generally will be produced. The chill should be heated before the iron is poured into the mold and this may be accomplished by pouring through the mold, about one-fourth as much iron as will be required to fill it. If too much iron is forced through, the chill will be decreased and will be prevented entirely. The quality of the iron will determine the amount of chill. A high chilling iron will give the best results. By pouring the iron into the mold, the chill will immediately be heated and, of course, will correspondingly produce a chilled casting.

In some way a shell should be formed on the casting before the iron in the center loses much of its heat. It should be sufficiently strong so that the iron inside of the shell shall solidify and cause all of the internal shrinkage to result in the formation of a coarse grain, or spongy spots at the center of the ball. The iron forms a thin skin the moment it strikes the surface of the chill; because of eddies caused by the flowing metal, some parts are more rigid than others. All of the heat which escapes from the interior of the ball must pass through this skin and this keeps it plastic. When the center cools, the volume of the iron decreases as the result of shrinkage and the surface of the melted iron will be lowered, the plastic skin on the top following it causing a sink in the surface. If the upper skin has strength enough to retain its spherical form the sink would occur where a thin and plastic skin remains, or if all parts of the skin or shell are rigid the centers will be spongy.

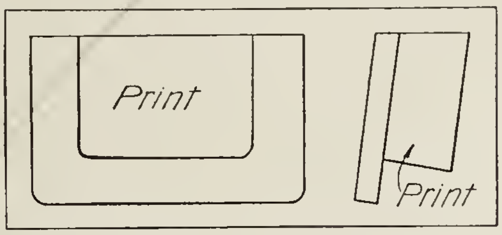


FIG. 4—END AND SIDE VIEWS OF STOP-OFF BLOCK

Further information from readers of THE FOUNDRY is sought on this practice, since it seems to be engaging considerable attention at present.

How Fuel Oil Briquettes Are Used

Owing to the scarcity of coke, unusual interest is manifested by foundrymen in the use of fuel oil residue briquettes, which contain an unusually high percentage of carbon and, therefore, greatly increase the temperature of the metal. On the Pacific coast, where coke is unusually high-priced at the present time, fuel oil residue briquettes are being used extensively. In one shop on the Pacific coast, after the second or third charge, fuel oil residue briquettes constitute a part of the burden in the proportion, by volume, of 75 per cent of coke to 25 per cent of briquettes. The briquettes weigh 60 per cent more than the same amount of coke by volume. In charging the briquettes, it is the practice to first charge one-half of the coke then the briquettes, followed by the remainder of the coke for a single charge. In this way the coke, to some extent, prevents the briquettes from crushing.

A blacking for cores and molds recently patented in the United States consists of 49 parts of coke dust, 32.5 parts of charcoal, 22.5 parts of pipe clay and 3 parts of raw starch. When applied the various ingredients are bonded with starch paste, and it is contended that the blacking is suitable for coating molds for steel, iron, copper, bronze and aluminum.

A British inventor produces a polishing and rust-preventing composition by leaving cottonseed oil in contact with lead for periods as long as 10 days. The lead may be in any convenient form and the oil and lead are kept in a closed vessel. After the solution has been run off, the lead is exposed to the air for a time and then may be used to treat a further supply of oil.

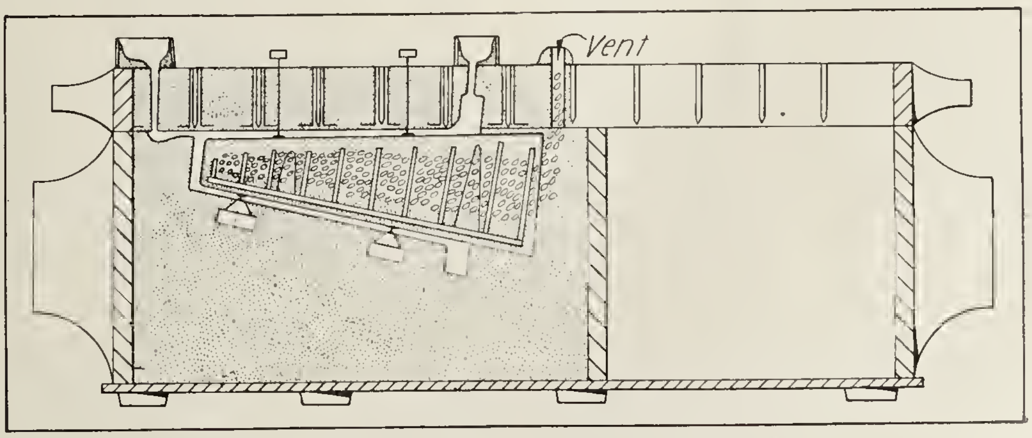


FIG. 5—CROSS SECTION OF THE FINISHED MOLD

Foundrymen Display Keen Interest in Boston Show

Number of Applications for Exhibitor's Space Promises to Exceed Previous Records—List of Reservations and Technical Papers Scheduled

WITH the total number of applications for space in Mechanics' building already in excess of the number of exhibitors at Atlantic City two years ago, and with the approximate floor area reserved considerably in excess of that occupied during that show, the success of the exhibition of foundry equipment and supplies, machine tools and accessories, to be held at Boston, Sept. 25 to 28, is assured. Indications now point to the greatest show of this kind ever held and it is probable that in number of exhibitors all records will be broken.

Manufacturers who have reserved space now are making preparations to ship their exhibits at an early date to avoid delays in delivery due to the congested condition of the railroads. As soon as delivered, all equipment will be stored in Mechanics' building until the date of the opening of the show. An added feature of the exhibit will be the display of motor trucks. Manufacturers of these vehicles have been extended an invitation by the exhibition committee of the American Foundrymen's association to display their products and a representative number of types undoubtedly will be displayed.

The complete list of manufacturers who already have reserved space follows:

Ajax Metal Co., Philadelphia.
Albany Sand & Supply Co., Albany, N. Y.
American Foundry Equipment Co., Cleveland.
American Gum Products Co., New York City.
American Lighting Co., Chicago.
American Molding Machine Co., Terre Haute, Ind.
Arcade Mfg. Co., Freeport, Ill.
Armstrong Cork & Insulation Co.. Pittsburgh.
Atkins, E. C., & Co., Indianapolis.
Ayer & Lord Tie Co., Chicago.

B. & B. Mfg. Co., Indianapolis.
Beaudry & Co., Boston.
Berkshire Mfg. Co., Cleveland.
Besly, Chas. H., & Co., Chicago.
S. Birkenstein & Sons, Chicago.
Blystone Mfg. Co., Cambridge Springs, Pa.
Brass World Publishing Co., New York.
Brown Specialty Machinery Co., Chicago.
Buckeye Products Co., Cincinnati.
Bullard Machine Tool Co., Bridgeport, Conn.

Cataract Refining & Mfg. Co., Buffalo.
Chase, Frank D., Chicago.
Champion Foundry & Machine Co., Chicago.
Chicago Pneumatic Tool Co., Chicago.
Chisholm & Moore Mfg. Co., Cleveland.
Cincinnati Pulley Machinery Co., Cincinnati.
Cleveland Blow Pipe & Mfg. Co., Cleveland.
Cleveland Milling Machine Co., Cleveland.
Cleveland Pneumatic Tool Co., Cleveland.
Coale, Thos. E., Lumber Co., Philadelphia.
Cutter & Wood Supply Co., Boston.
Davis-Bournonville Co., Jersey City, N. J.
Debevoise-Anderson Co., New York.
Dixon, Joseph, Crucible Co., Jersey City, N. J.
Drouve, G., Co., Bridgeport, Conn.

Federal Foundry Supply Co., Cleveland.
Felt & Tarrant Mfg. Co., Chicago.
Forbes & Myers, Worcester, Mass.

Gardner Machine Co., Beloit, Wis.
General Electric Co., Schenectady, N. Y.
General Fire Extinguisher Co., Providence, R. I.
Goldschmidt Thermit Co., New York.
Great Western Mfg. Co., Leavenworth, Kas.

Harrison Supply Co., Boston.
Herman Pneumatic Machine Co., Pittsburgh.
Hill, Clarke & Co., Boston.
Hoevel Mfg. Corporation, New York.
Holz, Herman A., New York.

International Molding Machine Co., Chicago
Iron Age, New York.

Jennison-Wright Co., Toledo.

Kelley, T. P., & Co., New York.
King, Julius, Optical Co., New York.

Lewis-Shepard Co., Boston.
Lupton's, David, Sons Co., Philadelphia.
Lynd-Farquhar Co., Boston.

McCrosby Reamer Co., Meadville, Pa.
McLain's System, Milwaukee, Wis.
MacLean Publishing Co., Toronto, Ont.
Malleable Iron Fittings Co., Branford, Conn.
Metal Industry, New York.
Michigan Smelting & Refining Co., Detroit.
Midland Machine Co., Detroit.
Monarch Engineering & Mfg. Co., Baltimore.
Mott Sand Blast Mfg. Co., Brooklyn, N. Y.
Mumford, E. H., Co., Elizabeth, N. J.
Mumford Molding Machine Co., Chicago.

National Engineering Co., Chicago.
New England Coal & Coke Co., Boston.
New Haven Sand Blast Co., New Haven, Conn.
Nicholls, Wm. H., Co., Brooklyn, N. Y.
Norma Co. of America, New York.
Norton Co., Worcester, Mass.

Obermayer, S., Co., Chicago.
Osborn Mfg. Co., Cleveland.
Oxweld Acetylene Co., Newark, N. J.

Pangborn Corporation, Hagerstown, Md.
Paxson, J. W., Co., Philadelphia.
Penton Publishing Co., Cleveland.
Pickands, Brown & Co., Chicago.
Pittsburgh Crushed Steel Co., Pittsburgh.
Portage Silica Co., Youngstown, O.
Pridmore, Henry E., Chicago.

Quigley Furnace Specialties Co., New York.

Railway Mechanical Engineer, Chicago.
Richey, Browne & Donald, Maspeth, N. Y.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Robeson Process Co., New York.
Rogers, Brown & Co., Cincinnati.

Sand Mixing Machine Co., New York.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Simonds Mfg. Co., Fitchburg, Mass.
Sly, W. W., Mfg. Co., Cleveland.
Smith, R. P., & Sons Co., Chicago.
Smith, Werner G., Co., Cleveland.
Standard Equipment Co., New Haven, Conn.
Strong, Kennard & Nutt Co., Cleveland.
Sullivan Machinery Co., Chicago.

Thomas Iron Co., Boston.
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

United States Graphite Co., Saginaw, Mich.
U. S. Molding Machine Co., Cleveland.
United States Silica Co., Chicago.

Wallace, J. D., & Co., Chicago.
Warner & Swasey Co., Cleveland.
Wheeler & Holcomb Co., Chicago.
White & Bro., Philadelphia.
Whitehead Bros. Co., Providence, R. I.
Whiting Foundry Equipment Co., Harvey, Ill.
Woodison, E. J., Co., Detroit.

Technical Program

That the technical features of this great gathering of foundrymen have not been neglected is reflected by the 44 papers that already have been secured, and to these must be added a large number of committee reports. The Boston meeting will be opened on Tuesday morning, Sept. 25, in place of Monday afternoon, as at Cleveland last year, and morning sessions only will be held, closing Friday, Sept. 28. Simultaneous sessions for the consideration of papers on gray iron, steel and malleable iron will be necessary to dispose of the lengthy program that has been prepared. Registration will open at the Copley-Plaza on Monday morning, but on Tuesday the headquarters will be transferred to Mechanics' building, where they will be continued throughout the remainder of the week.

The papers scheduled on the program, follow:

Symposium on "Military Stores":
  "Making Shells in Permanent Molds", by Edgar A. Custer, Philadelphia.
  "Military Stores", by Dr. F. C. Langenberg, Watertown Arsenal, Watertown, Mass.
  "Small Steel Castings for Ordnance Purposes", by Major C. M. Wesson, Watertown Arsenal, Watertown, Mass.
Symposium on "Refractories":
  "Refractory Materials Employed in the Metallurgical Industries", by H. C. Arnold, University of Illinois, Urbana, Ill.
  "Cupola Refractories", by G. E. Jones, Whiting Foundry Equipment Co., Harvey, Ill.
"Factors Contributing to the Economical Use of Grinding Wheels in the Foundry", by Wallace T. Montague, Norton Co., Worcester, Mass.
"Results of Tests in Blending and Mixing Sand by Means of Mullers", by R. F.

Harrington, Hunt-Spiller Mfg. Corporation, Boston.

"Experiences with Sand Mullers from their Conception to Their Final Application to the Foundry Industry", by P. L. Simpson, National Engineering Co., Chicago.

"Fillet-Sizes", by Frank E. Jones, University of Kansas, Lawrence, Kans.

"Sand-Blasting", by H. L. Wadsworth, Sand Mixing Machine Co., Cleveland.

"Efficiency in the Foundry", by Jas. A. Fitzgerald, Reno, Pa.

"The Metals of Technology", by John Ritchie Jr., Mass. Institute of Technology, Boston.

"Welfare Work in Southern Foundries", by J. F. Kent, American Cast Iron Pipe Co., Birmingham, Ala.

"Co-operative Shop Training", by W. B. Hunter, Industrial Department, Fitchburg High School, Fitchburg, Mass.

"Scientific Selection of Men", by Wm. Judson Kibby, Cleveland.

"Co-operation", by the Chicago Foundrymen's Club.

"The Labor Situation as Relating to Co-operation Between the Employer and the Employe", by G. E. Mac Ilwain, Babson's Statistical Organization, Wellesley, Mass.

"The Relationship of the Engineering Department to the Pattern Shop and Foundry", by F. J. McGrail, Struthers-Wells Co., Warren, Pa.

Gray Iron

"Seasoning Gray Iron Castings", by L. M. Sherwin, Brown & Sharpe Mfg. Co., Providence, R. I.

"The Foundry from the Viewpoint of the Sales Engineer", by H. R. Atwater, Osborn Mfg. Co., Cleveland.

"The Effect of High Sulphur in Agricultural Machinery Castings", by T. Mauland, International Harvester Co., Chicago.

"The Use of the Microscope in the Foundry", by R. J. Anderson, Cleveland Metal Products Co., Cleveland.

"Modern Centrifugal Cupola Blowers", by J. W. Shugg, General Electric Co., Schenectady, N. Y.

"Making Small Cores Under Economical Conditions", by R. E. Kennedy, University of Illinois, Urbana, Ill.

"Effect of Cupola Practice on the Quality of Iron", by G. S. Evans, Lenoir City, Tenn.

"Briquetting Foundry Borings", by A. L. Stillman, General Briquetting Co., New York.

"Effect of the Presence of Iron Oxide in Molding Sand", by W. R. Bean, Naugatuck Malleable Iron Works, Naugatuck, Conn.

"Machine-Made Cores", by Lewis G. Blunt, Romeo Foundry Co., Port Huron, Mich.

Steel

"Molding and Casting Large Slag Pots", by C. J. McMahon, Illinois Steel Co., Chicago.

"Recent Progress in the Application of the Electric Furnace to the Melting Problem", by C. H. Booth, Snyder Electric Furnace Co., Chicago.

"Discussion of the Electric Furnace from the Central Station Standpoint, with a Discussion of Power Rates and Measuring Power on a Maximum Demand Basis", by E. L. Crosby, Detroit Edison Co., Detroit.

"Data on the Treatment of Cast Iron in the Electric Furnace", by Jos. L. Dixon, John A. Cowley Co., Detroit.

"Description of a Small Open-Hearth Furnace", by David McLain, Milwaukee.

"Welding", by M. Stuart Plumley, Davis-Bournonville Co., Boston.

"The Use of Vanadium in Steel Castings", by J. Lloyd Uhler, Union Steel Castings Co., Pittsburgh.

"Comparison of the Electric Furnace and the Steel Converter for the Manufacture of Small Steel Castings", by C. R. Messinger, Sivyer Steel Casting Co., Milwaukee.

"A New System of Burning Crude Oil", by W. A. Janssen, Bettendorf Co., Davenport. Iowa.

Malleable Iron

"Waste Heat Boilers as Applied to the Malleable Melting Furnace", by A. W. Pratt, Babcock & Wilcox Co., New York.

"The Application of Pulverized Coal to the Malleable Melting and Annealing Furnace", by Jos. Harrington, Chicago.

"Application of Waste Heat Boilers to the Malleable Melting Furnace," by C. D. Townsend, Danville Malleable Iron Co., Danville, Ill.

"Strength of Malleable Iron", by Prof. Enrique Touceda, Albany, N. Y.

"Application of Pulverized Coal to the Malleable Melting Furnace", by W. R. Bean, Naugatuck Malleable Iron Works, Naugatuck, Conn.

"Malleable Iron Annealing; Comparative Carbon Losses and Muffle vs. Pot Ovens", by J. B. Deisher, T. H. Symington Co., Rochester, N. Y.

"Troubles Encountered in Machining Malleable Iron; Causes and Remedies", by A. T. Jeffery, Dayton Malleable Iron Co., Dayton, O.

A New Method of Making High-Speed Steel

A method of making high-speed steels containing tungsten, chromium and vanadium which consists in adding the alloying metals in the form of a hardener to a bath of molten iron, has been made the subject of a patent by Isador Ladoff, Wilkingsburg, Pa. The hardener is made by the simultaneous reduction of the oxides of tungsten, chromium and vanadium, with sufficient oxide of iron to form an alloy containing 50 per cent of the latter, and 50 per cent of tungsten, chromium and vanadium together, the latter three elements being in their respective *interrelated proportions* to form the desired alloy, when the hardener is added to the bath of molten iron or steel. The object of making this hardener, as disclosed by the inventors is to simplify the present process of producing high-speed steels by making the alloy in two operations instead of several, as at present. The two operations comprise making the hardener and then incorporating the same in a bath of iron or steel, in proportions necessary to form the desired high-speed steel. By the usual method, the alloying elements are first reduced to metal, or are made into a ferroalloy and then are added separately to the bath of steel, or are melted together with the steel in the proportions required. The invention reduces the steps necessary to produce such alloys.

The National Founders' Association has moved its New York office from 141 Broadway to 90 West street, New York. The office continues in charge of C. W. Burgiss, eastern representative.

To Increase the Melting Capacity of a Small Cupola

By W. J. Keep

Question:—Our cupola is home-made and while we have hot iron at the beginning of the heat, nevertheless, as the heat progresses the flow of the iron slows up almost entirely and slag and iron accumulate between the tuyeres and toward the center until there is only a small opening left. The cupola is 30 inches inside diameter, the blast being furnished by a fan. The wind box is 8½ x 9 inches and extends two-thirds around the cupola. The blower outlet is 10 inches in diameter and the four tuyeres each have a diameter of 3¾ inches. The air pressure is 4½ ounces and the blower motor is 7-horsepower.

Answer:—I hardly think that you can do good work under present conditions, even if you should make some changes in your cupola. It is somewhat difficult to obtain good results with a 30-inch furnace unless the foreman or melter is well versed in cupola operations. We obtain magnificent results with a cupola 22 inches in diameter melting a two-ton heat. I have used a furnace, 16 inches in diameter, on a 500-pound heat. Also, at present I am using a cupola lined to 28 inches to produce heats from 2½ to 5 tons. You may be trying to melt too much iron, since three to five tons would be the limit and you may now be doing this before your trouble actually begins. I suggest that the pig iron be broken into pieces weighing approximately 25 pounds and the scrap likewise should be broken into pieces of this size. Charge carefully and evenly, using 20 pounds of coke for each 100 pounds of iron. Also be careful not to charge dirt or sweepings from the charging floor. The silicon should be increased to about 2.50 per cent. The cupola should have six tuyeres, 8 inches wide and 3 inches high in the opening. Leave an 8-inch blank space in the back. The bottoms of the tuyeres should be at least 10 inches from the sand bottom and this distance should be greater if you need more iron for a casting than you can catch in ladles. Make a slag hole in the back of the cupola and tap the slag as soon as it will come down. Use a two-quart measure of good limestone on each charge, which should be broken as small as a hen's egg. The blast pressure should be six or seven ounces, requiring only a 5-horsepower motor.

The Federal Foundry Supply Co., Cleveland, has acquired the building and site which it now occupies on E. Seventy-ninth street.

THE FOUNDRY

A monthly journal devoted to all branches of the foundry trade

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Contents

WHAT THE WAR HAS IN STORE FOR THE FOUNDRY TRADE.......... 253
ELECTRIC STEEL OUTPUT INCREASES 85 PER CENT.................. 254
HOW CORES FOR MOTOR CAR CASTINGS ARE MADE.................. 255
BOOK REVIEWS 260
INCREASING THE OUTPUT OF THE PLATING ROOM.................. 261
THE EVOLUTION OF THE DIE-CASTING PROCESS.................. 265
TESTING SOCIETY CONSIDERS NEW SPECIFICATIONS.................. 270
TENTATIVE SPECIFICATIONS FOR SOIL PIPE AND FITTINGS.......... 270
RESULTS OF TESTS OF SAND-CAST METALS AND ALLOYS.......... 271
THE 88-10-2 ALLOY.. 271
PROPERTIES OF MANGANESE BRONZE.................................. 272
PROPERTIES OF THE 80-10-10 ALLOY.................................. 272
TEN PER CENT ALUMINUM BRONZE.................................. 273
ALUMINUM, 92 PER CENT AND COPPER, 8 PER CENT.................. 273
THE EARLY USE OF PERMANENT MOLDS FOR CASTINGS.................. 274
ELECTRIC FURNACE AS A COPPER-MELTING MEDIUM.................. 280
PROBLEMS OF THE BRASS FOUNDER.................................. 283
UTILIZING COPPER TURNINGS.. 283
IMPROPER MELTING METHODS.. 283
CASTINGS SUBMITTED TO HYDROSTATIC TEST.......................... 283
COPPER-PLATING ALUMINUM 283
SOLDERING ALUMINUM BRONZE CASTINGS.......................... 284
METHOD OF BABBITTING THRUST COLLARS.......................... 284
ANALYSES FOR ANTI-FRICTION METAL.................................. 284
MIXTURES OF ALLOYS SIMILAR TO DURALUMINUM.................. 284
DIFFICULTIES ARISING FROM THE USE OF LEAD.................. 284
MAKING CASTINGS FOR PIANOS.. 285
CHEAP RED BRASS MIXTURES.. 285
WHITE METAL PATTERN ALLOY.. 285
IRON AND PHOSPHORUS CAUSE HARDNESS.......................... 285
NOMENCLATURE OF ALUMINUM ALLOYS.................................. 285
FORGINGS FOR FUSE CAPS.. 285
ADVANTAGES OF HAND AND POWER MACHINE MOLDING.................. 286
PATTERN ECONOMY IN MOLDING A FAN PEDESTAL.................. 288
HOW TO MAKE CHILLED CAST IRON BALLS.......................... 289
FOUNDRYMEN DISPLAY KEEN INTEREST IN BOSTON SHOW.......... 290
TO INCREASE THE MELTING CAPACITY OF A SMALL CUPOLA.......... 291
TAKE ADVANTAGE OF THIS OPPORTUNITY.......................... 292
TRADE OUTLOOK 292
TENTATIVE SPECIFICATIONS FOR RAILROAD MALLEABLE CASTINGS...... 295
WHAT THE FOUNDRIES ARE DOING.................................. 296

Take Advantage of This Opportunity

IN THE few months since the United States entered the war, the wheels of preparedness machinery have been set in motion with a swiftness that has surprised even the most optimistic. Every day new contracts are announced which impose additional strains on overtaxed manufacturers. The gigantic programs of shipbuilding, aeroplane manufacture, munitions-making and military camp construction insure work for every branch of industry. Every maker of steel, gray iron, malleable or nonferrous castings is abundantly supplied with orders.

The rapidity with which much of this war business has developed and the novelty of some of the work foundries are asked to produce challenges the resourcefulness of foundrymen. As pointed out in the May issue of THE FOUNDRY, the events of the past few years have prepared the industry for the present conflict, but the newest preparedness campaign presents problems which cannot be solved by dint of previous training or experience. To retain the confidence gained in the past, makers of castings must promptly and successfully work out solutions of the fresh complexities and American ingenuity must find a means of increasing the production without lowering the quality.

The unusual responsibility thrown upon foundrymen should not be regarded as a burden; it should be welcomed as an opportunity for demonstrating efficiency and resourcefulness. The foundries of European belligerents, which before the war were far behind American plants in their development, have made a fine record of achievement. The opportunity to surpass our Allies in this respect is ours. Let us take advantage of it.

Trade Outlook

DURING the past month, the price of pig iron has passed the $50 mark, and now is well on its way to the $75 level. Authorities who are familiar with the market claim that there will be a shortage of foundry and malleable pig iron during the next year. The coke situation remains unaltered, the labor supply and car shortage being the limiting factors. Bessemer iron is held at $55, valley, and basic from $50 to $52, valley. No. 2 foundry iron is quoted in the leading trade centers as follows: Pittsburgh, $53.95 to $55.95; Chicago, $52.50; Cleveland, $50 to $51; Buffalo, $47 to $50; Birmingham, $43 to $45; and Philadelphia, $48.50 to $49.50. Malleable pig iron is listed at $53.95 to $55.95, Pittsburgh; $52, Chicago; and $47 to $50, Buffalo. Lake Superior charcoal iron is quoted at $55 to $57.50, Chicago. Prompt foundry coke is selling from $12 to $12.50, Connellsville, and fuel for second half delivery is quoted at the same price. Ferromanganese is quoted at $425 to $475, Pittsburgh, and 50 per cent ferrosilicon is held at $250, Pittsburgh. Heavy melting steel sells at from $33 to $47.

Equipment for Reclaiming Core Sand

A continuous core reducer recently developed by the National Engineering Co., Chicago, is shown in Fig. 1. It consists of a horizontal iron drum of heavily reinforced sections bolted to circular end pieces fitted with trunnions on which it is revolved by gears taking power from a belt. In operation it is similar to a tumbling barrel, except that the side sections are perforated for the escape of the sand when it has been sufficiently broken apart. The side sections can be removed to give access to the interior and remove the accumulation of core rods and wires when necessary. Usually, as many of the rods as possible are removed before the cores are passed to the reducer, a magnetic separator being efficient in taking out such as may be loosened from the sand.

The reducer illustrated is 4 feet in diameter, 6 feet long, weighs 6 tons and operates at 20 revolutions per minute. The holes are spaced 1½ inches and are ⁵⁄₁₆ inch in diameter on the inside of the plate, flaring to ⅝ inch on the outside.

In practice the cores are fed from a belt into the hopper at the right of the illustration. In the drum the material is brought into contact with steel or iron balls, pieces of pig iron or other heavy material. The revolution of the drum causes the heavy objects to break up the cores and as fast as the sand reaches a sufficient degree of fineness it sifts through the holes to the floor and thence is conveyed to storage.

Function of Screen Separator

In one installation the reclaimed sand passes over a screen separator which removes the coarse and fine particles and retains the middles, which drop into a bin above the mixer. This separator, also made by the National Engineering Co., consists of two screen surfaces, one of 30 mesh and one of 70 mesh, the material passing through the coarser and over the finer screen being the portion saved. The separator is shown in Fig. 2.

Sand from the bin is fed through a gate in the bottom to the pan of a foundry mixer where binder, new sand and water are added, each being fed from a suitable container arranged to deliver its contents into the mixer. With this arrangement one man can control the mixing of 6 to 8 tons per hour of core material.

An analysis of Michigan City sand, such as is used for coremaking, shows that it is made up of the following sized grains:

	Per cent
20 mesh	0.3
40 mesh	7.3
60 mesh	63.5
80 mesh	23.5
100 mesh	5.1
Through	0.3
	100.0

From this it will be noted that 60 to 80 per cent of the sand would fall between 30 and 70 mesh screens.

Personals

Louis Lesperance, formerly located at Kokomo, Ind., has been appointed superintendent of the foundry operated by the Rumsey Pump Co., Seneca Falls, N. Y.

W. J. Scholes has been appointed superintendent of the foundry branch of the General Motors Co., located at Stockton, Cal., where gas tractors are manufactured.

The Goldschmidt Thermit Co., New York, manufacturer of ferroalloys and metals, is erecting a welding plant, 35 x 106 feet, on Western avenue, Pittsburgh.

Louis Rasmussen, superintendent of the Wisconsin Aluminum Foundry Co., Manitowoc, Wis., has resigned to accept a position at Marshalltown, Ia.

Robert Parks, formerly general manager of the Bettendorf Co., Bettendorf, Ia., now is associated with the Canadian Car & Foundry Co., Montreal.

J. H. Steedman, vice president and general manager of the Curtis Pneumatic Machinery Co., St. Louis, has been appointed a lieutenant in the United States navy.

Henry F. Russell has resigned from the sales force of the Lumen Bearing Co., Buffalo, to become sales manager of the foundry division of Farrar & Treffts, Buffalo.

I. S. Fouse, formerly associated with the Standard Steel Car Co., Pittsburgh, with works at Butler, Pa., now is general manager of the Allegheny Foundry & Machine Co., Glassmere, Pa.

James H. Slawson, Chicago sales agent of the National Malleable Castings Co., Cleveland, has been elected vice president of the Joliet Railway Supply Co., Joliet, Ill., a subsidiary of the Northwestern Malleable Iron Co., Milwaukee.

T. N. McEuen has been appointed representative of the E. J. Woodison Co., Detroit, manufacturers of foundry and platers' supplies, in the states of Iowa and Nebraska, Mr. McEuen formerly was attached to the Milwaukee office of this company.

Arthur F. Braid has assumed the duties of metallurgical engineer in charge of metal sales of the Goldschmidt Thermit Co., Jersey City, N. J. He succeeds de Courcey Brown, who has joined the officers' reserve corps at Plattsburg, N. Y., and probably will continue in the service of the army.

David Evans, president of the Chicago Steel Castings Co., Chicago, and senior partner of the David Evans & Co., Chicago representatives of the Sloss-Sheffield Steel & Iron Co., is serving the government as captain of a motor truck company at Fort Sam Houston, Texas. Mr. Evans served in the Spanish-American war.

Robert Radford has been elected president of the Southwark Foundry & Machine Co., Philadelphia, succeeding W. L. Abbott. Mr. Radford began his business career with the Baldwin Locomotive Works in 1894. For the past few years he has filled the office of secretary-treasurer of the Standard Steel Works Co., Philadelphia, with plants at Burnham, Pa., and will continue in this capacity.

C. A. Newman, formerly manager of sales promotion for Henion & Hubbel, Chicago, dealers in power pumps, mining and mill supplies, has been

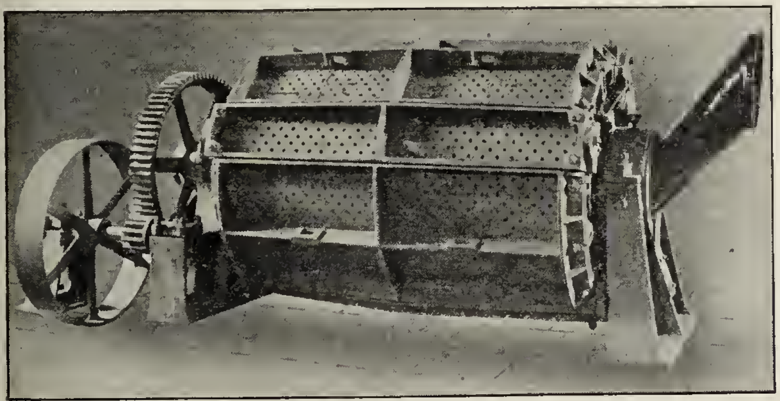

FIG. 1—MACHINE FOR REDUCING CORE SAND

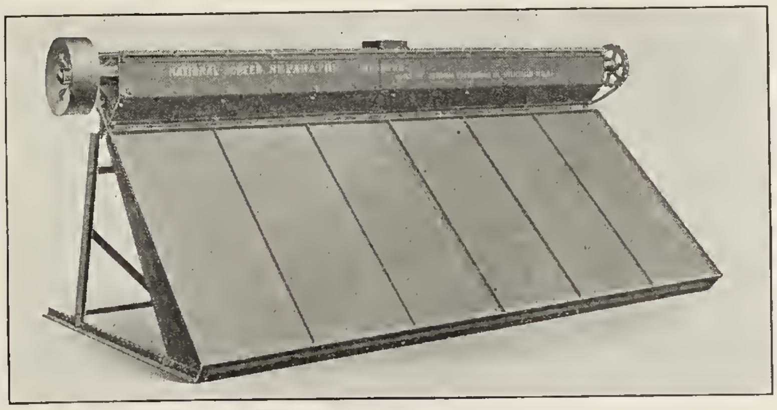

FIG. 2—SCREENS ELIMINATE COARSE AND FINE PARTICLES

appointed sales manager of the Boiler-Kote Co., Fisher building, Chicago.

G. S. Evans, who recently resigned as superintendent of the foundry of the Lenoir Car Works, Lenoir City, Tenn., is engaged in the construction of a large steel and gray iron foundry and machine shop at Atlanta, Ga., and he will be placed in charge of the operations of this plant when it is completed.

Henry M. Leland, general manager of the Cadillac Motor Car Co., Detroit, and his son, Wilfred C. Leland, who have been prominently connected with the perfection of gasoline engines, have announced their retirement from the automobile industry to devote their time and interests to the call of the nation. They are dedicating their services to the task of building a powerful aeroplane fleet which will give the United States the mastery of the air in the present war. R. H. Collins of Detroit succeeds Mr. Leland as general manager of the Cadillac Co., and for the last two years he has been assistant to President W. C. Durant of the General Motors Co.

Joseph Harrington, advisory engineer in the use of powdered coal as fuel, has organized the United States Power & Furnace Co., with headquarters at 208 South La Salle street, Chicago. This corporation will enable Mr. Harrington to enlarge greatly the scope of his activities and will enable him further to promote economies in the use of coal as fuel in industrial practice. The United Power & Furnace Co. is prepared to design and construct powdered coal installations, metallurgical and special furnaces, steam power plants, pumping stations and all apparatus for the economical burning of fuel. The officers of the company follow: Joseph Harrington, president; Carl Heim, secretary and treasurer, and William A. Nelson, vice president and general manager.

The Schwartz Deoxidizing and Refining Process

A process for deoxidizing and refining ferrous metals is the title of a patent granted to Edward H. Schwartz, Chicago. It consists of melting in a cupola, a mixture of high carbon and manganese steel scrap, or spiegeleisen and high silicon pig iron, with a suitable amount of limestone as a flux, with the object of obtaining a product of relatively high carbon content, which can be converted into steel by treatment in an electric, open-hearth or reverberatory furnace or in a converter, or can be used as cast iron suitable for machinery castings or for car wheels. To make the latter, a mixture of 40 per cent pig iron containing 1 per cent silicon and 0.4 per cent manganese is made with 30 per cent of steel scrap and 30 per cent of cast malleable iron railway scrap. This is melted in a cupola from which it is transferred to an open-hearth refining furnace where sufficient spiegeleisen is added to bring the manganese to about 0.8 per cent, and enough ferro-silicon to bring the silicon content to approximately 0.75 per cent. The metal then is refined until the silicon is reduced to 0.6 per cent and the manganese to 0.75 per cent, when the inventor states the whole mass of metal will have been thoroughly deoxidized and refined and may be cast into wheels.

Core Compound Manufacturers Beware!

That the merits of core compound are not generally appreciated by casting manufacturers is indicated by the following acknowledgment from a southern foundryman, of a circular devoted to "Ebony Core Compound", issued by the Hill & Griffith Co., Cincinnati:

The Hill & Griffith Co.
Sir youre cirkler recieved without date as menny others has bin

while I respecte you as gentlemen I beg to call youre attensian to my experiance on Core Compound.

in date of 1895 I bought one Brl. of the very beste core compount that human tung could describe it inclooswe don away withe all eavles and furnished evreythin nessary to make porfect castings in all respects.

I supose I moste opend the Bbl at the rong ende as it prooved oposet fram recamendation

my first thought after givin it a trial was to throw it in mud hole on street.

I was afrade I would git in truble withe city about blowing up the street. my next though I would throw in in mere by creek.

I ferde I would blow up som mill acrost the cree below. I found it was insaent if let alone. I furnish it Hooseroon and worked around it fourteen years to keepe fram havin enny moore truble withe core compound.

in date of 1909 my pland got consumed by fire and relieved me of this mizrable Bbl of core compound.

no more core compound for me if you plese.

Death of W. W. Green

W. W. Green, president of the Garden City Fan Co., Chicago, died at his home in Niles, Mich., Saturday, June 2. Mr. Green was born at Williamston, Mass., Dec. 9, 1838, but in 1872 moved to Chicago and established the plant of which he was president many years. In 1902 the works were moved to Niles, Mich., and Mr. Green established his home in that city.

Gray and Benjamin, Advertising Counsellors

A. A. Gray and Charles L. Benjamin have organized the firm of Gray & Benjamin, with headquarters in the Transportation building, Chicago, and will serve as advertising counsel to manufacturers of electrical, mechanical, chemical and kindred products. They will analyze and report upon problems of manufacture and distribution and will supervise the preparation of advertising copy for technical and trade papers, booklets, house organs, catalogs and incidental advertising propaganda. Mr. Gray was managing editor of the *Electrical Review and Western Electrician* for many years and also served a term as president of the Federation of Trade Press Associations, and more recently, was president of the Associated Business Papers, Inc.

Mr. Benjamin has been engaged in advertising work since 1888. For a period of nine years, he was advertising manager of the Cutler-Hammer Mfg. Co., Milwaukee, and for the past two years he was engaged in advertising work on his own account, acting and advertising counsel to a number of manufacturers of nationally known products.

Specifications for Soil Pipe

(*Continued from page 270*)

little damper than usual, well mixed and put through a No. 8 sieve, with a mixture of 1 to 12 bituminous facing. The mold shall be rammed evenly and fairly hard, thoroughly dried and not cast until it is cold. The test bar shall not be removed from the mold until cold enough to be handled. It shall not be rumbled or otherwise treated, being simply brushed off before testing.

6.—When placed horizontally upon supports 12 inches apart and tested under a centrally applied load, the arbitration test bars, specified in Section 5, shall show a transverse strength of not less than 2500 pounds, and the deflection shall not be less than 0.1 inch.

7.—All pipe shall be tested to a hydrostatic pressure of not less than 50 pounds per square inch before coating. Any casting showing defects under this hydrostatic test shall be promptly broken and returned at once to the cupola.

Standard Sizes and Weights

8.—(*a*) The inside diameter of the barrel of any pipe or fittings or branch thereof shall not vary more than $\frac{1}{8}$ inch under the nominal size of pipe.

(*b*) The outside diameter of the barrel of pipe and fittings shall be $\frac{1}{2}$ inch greater than its nominal inside diameter. A variation in the outside diameter of $\frac{1}{8}$ inch over or under these figures will be permitted.

(*c*) All pipe and fittings shall be of uniform thickness of wall and present true circles at the hub and spigot ends. A variation of $\frac{1}{16}$ inch under the following dimensions will be permitted, but only when the actual weight is not less than the variation of the marked or estimated weight as given in Tables I and II:

Thickness of:	Inch
Barrel	1/4
Body of hub....................	5/16
Bead of hub.....................	1/2
Bead of spigot end..............	7/16

9.—(*a*) Weights and measurements of pipe and fittings shall be taken as those of plain uncoated pipe. All weights shall be given in pounds.

(*b*) Individual lengths of pipe and fittings may weigh 5 per cent less than designated in Tables I and II, but only when the average weight of a given size and weight of pipe and fittings selected at random, is not less than that shown in Tables I and II.

(*c*) The regular length of pipe shall be such as to lay 5 feet including hub.

(*d*) The average weights of soil pipe and fittings shall not be less than those given in Tables I and II.

Table I.

WEIGHTS OF SOIL PIPE

	Single hub		Double hub
Size, inches	Per 5-foot length, pounds	Per foot including hub, pounds	Per 5-foot length, pounds
2.............	27½	5½	27½
3.............	47½	9½	47½
4.............	65	13	65
5.............	85	17	85
6.............	100	20	100

10.—(*a*) All pipe and fittings shall be practically straight and cylindrical and fittings true to pattern. The specified sizes shall be for the inside diameter and shall conform, within the allowable variation, to the dimensions given in the tables.

(*b*) All pipe and fittings shall be carefully examined for defects and sounded with a hammer before shipment. No fillings with metal, cement or other material, or so-called burning-on of iron will be permitted. The castings shall be sound and free from cracks, sand-holes, blow-holes and cold-shots.

11.—All pipe and fittings shall be marked with the manufacturer's name or appropriate initial. Every casting shall have cast upon it the minimum or estimated weight of the same as shown in Tables I and II.

Table II.

WEIGHTS OF SOIL PIPE FITTINGS

Only the Staple Fittings are Shown. From the Data Herewith the Weights of Other Fittings May be Calculated

All values are in pounds

	Size of fittings, inches														
Fittings	2	3	4	5	6	3 by 2	4 by 2	4 by 3	5 by 2	5 by 3	5 by 4	6 by 2	6 by 3	6 by 4	6 by 5
¼ bends, regular.	6¾	10¼	15	19	23½	..	..	..	..	..	..	..	..	..	..
¼ bends, short sw'p	8¼	12½	17¾	22½	27½	..	..	..	..	..	..	..	..	..	..
¼ bends, long sw'p	10¼	15¾	22	27½	33½	..	..	..	..	..	..	..	..	..	..
⅕ bends	6¼	9¾	13¾	17½	21½	..	..	..	..	..	..	..	..	..	..
1/6 bends	6	9¼	13	16½	20	..	..	..	..	..	..	..	..	..	..
⅛ bends	5½	8½	12¼	15¼	18¼	..	..	..	..	..	..	..	..	..	..
1/16 bends	5	7¾	10¾	13¼	15¾	..	..	..	..	..	..	..	..	..	..
Return bends.....	8¾	14	20¼	26½	33½	..	..	..	..	..	..	..	..	..	..
Tees	10¼	15¼	21	26½	32½	13¼	16½	18¾	19¼	22	24½	22½	25	27½	30
Tapped tees (tapped up to 2 in.)....	8¾	..	..	..	..	11¾	15	..	17¾	..	..	20½	..	..	..
Sanitary tees.....	11	16¼	22½	28	34½	14	17¼	19¾	20	23	25½	23	26	29	31½
Tapped sanitary tees (tapped up to 2 in.)	9	..	..	..	..	12	15¼	..	18	..	..	21¼	..	..	..
Y branch	11	17	24	31½	39½	14	17¼	20½	20	23½	27½	23	27	31	35
½ Y branch.....	10¼	15½	21½	27½	34	13½	16½	19	19½	22	25	22½	25½	28½	31
Tapped inverted Y branch (tapped up to 2 in.).......	10¼	13¾	17½	21	24	..	..	..	..	..	..	..	..	..	..
Inverted Y branch	11½	18	25½	33	41½	15	18¾	22	22	25½	29½	25½	29½	33	37
Combination Y and ⅛ bend	12	18¾	27	35	44½	15	18¼	22½	21	25½	30½	24	29	34	39
Upright Y branch	12½	19½	28	36½	46	15¾	18¾	23	21½	26½	31½	24½	29½	35	40

Inspection and Rejection

12.—The manufacturer shall afford the inspector representing the purchaser, free of cost, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications. All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works, and shall be made prior to shipment, unless otherwise specified.

13.—All pipe and fittings which fail to conform to the provisions of these specifications shall be subject to rejection.

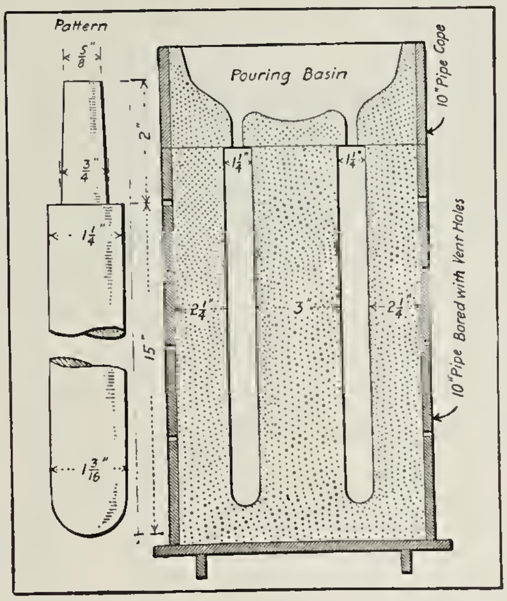

FIG. 1—MOLD FOR ARBITRATION TEST BAR

Tentative Specifications for Railroad Malleable Castings

1.—The castings shall be produced by either the air furnace, open-hearth or electric furnace process.

2.—Tension test specimens specified in Section 5 shall conform to the following minimum requirements as to tensile properties:

Tensile strength, pounds per square inch 45,000
Elongation in 2 inches, per cent...... 7.5

3.—Transverse test specimens specified in Section 5, tested with the cope side up on supports 12 inches apart, pressure being applied at the center, shall sustain a load not less than 2100 pounds, and show a minimum deflection of 1.125 inch.

4.—(*a*) In the case of castings of special design and importance, test lugs shall be cast of a size proportional to the thickness of the castings but not exceeding ⅝ by ¾ inch in cross-section. On castings which are 24 inches or over in length, a test lug shall be cast at each end. These test lugs shall be attached to the casting at such point that they will not interfere with the assembling of the casting and may be broken off by the inspector.

(*b*) If the purchaser or his representative so desires, a casting may be tested to destruction. Such a casting shall show good, tough malleable iron.

5.—(*a*) Tension test specimens shall be of the form and dimensions shown in Fig. 1. Specimens whose mean diameter at the smallest section is less than 19/32 inch will not be accepted for test.

(*b*) Transverse test specimens shall be 14 inches in length, 1 inch in width and ¾ inch in thickness, and shall not vary more than 1/32 inch in either sectional dimension. Before the test is made, the specimen shall be center punched in accordance with Fig. 2, and after test, the deflection shall be measured as shown.

(*c*) Two tension and two transverse test specimens shall be cast from each melt, without the use of chills, with risers of sufficient height at each end to insure sound bars.

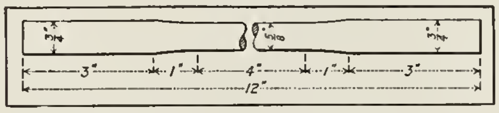

FIG. 1—FORM AND DIMENSIONS OF TENSION TEST SPECIMEN

These bars, representing the castings from each heat, shall be suitably marked to insure identification and annealed with the castings.

6.—One tension and one transverse test specimen representing each melt shall be selected for test. The remaining specimens shall be reserved and shall be tested in case of failure of the first test to conform to the requirements specified.

Sections 7 to 10 deal with details of marking castings, conforming to drawings, etc.

11.—(*a*) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the castings ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise ordered by the purchaser, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(*b*) The manufacturers shall be required to keep a record of each melt from which castings are produced, showing tensile strength and elongation of test bars cast from such melts. These records shall be available and shown to the inspector whenever required.

12.—Castings which show injurious defects subsequent to their acceptance at the manufacturer's works may be rejected, and if rejected, shall be replaced by the manufacturer free of charge to the purchaser.

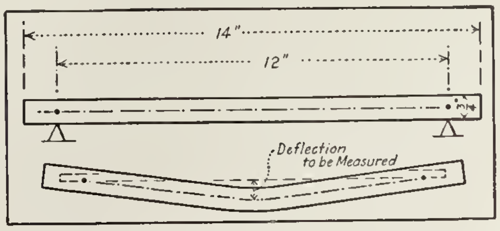

FIG. 2 — HOW THE DEFLECTION OF THE TEST SPECIMEN IS TO BE MEASURED

Presented at the annual meeting of the American Society for Testing Materials.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Baxter Stove Co., Mansfield, O., has announced its retirement from business.

The American Iron & Brass Co., Oakland, Cal., is building an addition to its plant.

The Detroit Brass Works, Retroit, will build a 5-story factory and foundry building.

The Decatur Malleable Iron Works, Decatur, Ill., will build an addition, 80 x 100 feet.

The Stafford Co., Reedville, Mass., recently completed a new gray iron foundry.

The American Machine Foundry Co., Brooklyn, N. Y., is building a 4-story plant, 120 x 150 feet.

The Kilby Mfg. Co., Cleveland, will erect a pattern shop, and a sprinkler system also will be installed.

The St. Paul Foundry Co., St. Paul, has purchased the site for the erection of a plant at a cost of $40,000.

The Monarch Foundry Co., Stockton, Cal., contemplates the erection of a machine shop, 100 x 150 feet.

The Colonial Brass Co., Middlesboro, Mass., is erecting an addition to its plant, 30 x 60 feet.

The Manhattan Brass Co., New York, has awarded a contract for the erection of a 7-story building.

The Plumbers' Woodwork Co., Algoma, Wis., is erecting a foundry addition, 30 x 50 feet.

The Ireland & Matthews Mfg. Co., Detroit, will erect a 2-story foundry building at a cost of about $20,000.

The Huntington Steel Foundry Co., Huntington, Ind., is erecting a 2-story, 40 x 80-foot addition to its plant.

The Columbus Malleable Iron Co., Columbus, O., has commenced the construction work on a $10,000 addition.

The St. Paul Foundry Co., St. Paul, is erecting a 2-story building at a cost of $12,000.

The Spring City Foundry Co., Waukesha, Wis., manufacturer of gray iron castings, is building an addition, 80 x 140 feet.

The Southern Illinois Machine & Foundry Co., Murphysboro, Ill., will build a foundry, forge and car shop, 60 x 120 feet.

The Bay State Smelting & Refining Co., Chelsea, Mass., has been incorporated with $25,000 capital by Harry Ficksman, Jacob Levendorf and G. Ficksman.

The Hershey Foundry & Machine Co., Manheim, Pa., is erecting a 50 x 300-foot pattern storage building and a 40 x 90-foot cleaning room.

The Wisconsin Aluminum Foundry Co., Manitowoc, Wis., is installing six additional furnaces and is building an addition, 30 x 190 feet.

The Bay View Foundry Co., Sandusky, O., is building an addition to its plant, 60 x 120 feet, which will be devoted to the cleaning of castings.

The Atlas Crucible Steel Co., Dunkirk, N. Y., is erecting a producer gas plant. Additions to its melting department recently were completed.

The Whitney-Mead Commercial Co., Los Angeles, Cal., will erect a plant, 110 x 210 feet, for the manufacture of cast iron sanitary enamel and hollowware. The initial plant, when equipped will cost $50,000.

The Superior Iron & Steel Corp., has been incorporated at Wilmington, Del., with $3,000,000 capital to engage in the operation of an iron foundry. The incorporators are H. G. Eastburn, Artemus Smith and M. R. Doto.

The plant of the Marietta Agricultural Works, Marietta, Pa., which has been idle for a number of years, has been sold to the Pittsburg Brass & Iron Foundry, which will remodel the works and place them in operation.

The Standard Foundry Co., New Kensington, Pa., recently was organized with a capital of $50,000 and will engage in the operation of a jobbing gray iron foundry. The officers follow: Horton Penrose, president; M. F. Christian, vice president, and W. G. Kenney, secretary and treasurer.

The Mishawaka Brass Foundry Co., Mishawaka, Ind., is the firm name of the company succeeding the South Bend Brass Foundry & Machine Co. A specialty is made of brass, bronze, aluminum and white metal castings. The officers of the company follow: George H. Thayer Jr., president; W. H. Young, treasurer; P. M. Thayer, secretary, and James J. MacGuire, superintendent.

The Beckemyer Foundry Co., has been organized at Beckemyer, Ill., with $8000 capital to engage in the operation of a foundry for the production of gray iron, semisteel, brass and aluminum castings. A plant, 60 x 100 feet, now is being erected. The incorporators are H. O. Briefield and W. L. Timmons. W. G. Keller has been appointed general manager and superintendent.

The new plant of the Ecorse Foundry & Machine Co., Ecorse, Mich., has been placed in operation. It is equipped to manufacture light gray iron castings and has a capacity to melt 100 tons of iron daily. The officers of this company follow: B. F. Everitt, president; W. A. C. Miller, vice president, and A. J. Kinnucan, treasurer and general manager.

New Construction

The Perkins Foundry Co., Inc., Amsterdam, N. Y., has increased its capital from $20,000 to $50,000.

The Industrial Foundry & Machine Co., Pottstown, Pa., has completed an addition to its plant, 50 x 135 feet.

The Bedford Foundry & Machine Co., Bedford, Ind., is erecting an addition to its foundry, 50 x 80 feet.

The Arcade Malleable Iron Co., Worcester, Mass., is building a foundry addition, 75 x 150 feet, at a cost of $12,000.

Southard, Robertson & Co., Peekskill N. Y., will erect a 2-story stove plant at a cost of $35,000.

The Atlas Crucible Steel Co., Buffalo, is building a transformer house and laboratory building, 30 x 76 feet and 32 x 62 feet.

The Rockford Union Foundry Co., Rockford, Ill., has been incorporated with $25,000 capital, by H. L. Olson, W. A. Brolin and Shelby L. Large.

The Camden Foundry Co., Camden, Ark., whose plant recently was destroyed by fire, has completed a new fireproof building for its shop.

The Woodward Foundry & Machine Co., Woodward, Okla., has been incorporated with $25,00 capital, by Charles H. Martin, Henry Hageman and William H. Smith.

The Standard Brass Tube Co., New London, Conn., recently taken over by the Bridgeport Brass Co., will build two additions to its foundry, 65 x 150 feet and 45 x 65 feet, respectively.

The Gallison Brass Foundry, Lawrence, Mass., has been incorporated with a capital stock of $5000. The directors are P. C. Wiggin, president; Francis B. Mowry, treasurer, and William Gallison.

The Mal-Gra Castings Co., which recently removed its sales office from Cincinnati to Middletown, O., states that it will not remove its foundry from Cambridge City, Ind., to Middletown, as reported.

The Wheel & Foundry Co., Ltd., Ont., has ben incorporated with $25,000 capital, by Arthur J. Thompson, 132 Balmoral avenue; William S. Morelock, 107 Roxborough street, west and R. H. Permenter.

The Dominion Foundries & Steel, Ltd., Hamilton, Ont., has been incorporated with $6,000,000 capital to take over the business now operated by the Dominion Steel Foundry Co.

The American Locomotive Co., New York, has purchased from the Penn-Seaboard Steel Casting Corp., the Seaboard Steel Castings Co.'s plant at Chester, Pa., which has a capacity of about 18,000 tons of steel castings annually.

The Pelton Steel Co., Milwaukee, is installing a 3000-pound Snyder electric furnace which duplicates the original installation of this equipment. The present schedule of five heats daily, is to be increased to seven, the two furnaces to be used alternately.

The Glover Machine Works, Atlanta, Ga., will install an electric melting and refining furnace to be furnished by the John A. Crowley Co., Detroit. The foundry building, which already has been erected, will be commanded by a 40-foot crane of 15 tons capacity.

The Glover Machine Works, Marietta, Ga., will install an electric furnace for the manufacture of steel castings as well as a forge shop and such equipment as steam hammers, sand-blast machinery, grinders, sand mixing machinery, etc., now is being purchased. A specialty will be made of the manufacture of industrial locomotives.

The Central Texas Iron Works, Waco, Tex., has been organized with $26,000 capital and will erect a plant for the manufacture of gray iron castings, the fabrication of structural steel and the building of a cast canning furnace. F. A. Winchell is president, Jas. T. Stubbs, vice president and Oliver Winchell, secretary.

The foundry of the Ames Plow Co., Framingham, Mass., is to be enlarged in the near future. It is the intention to devote this plant to the manufacture of heavy castings, some of which now are being made by the Woonsocket Machine & Press Co., Woonsocket, R. I., an allied concern. The Woonsocket company's foundry, when the change is made, will be devoted entirely to the production of castings for light textile machinery.

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Casting Chilled Car Wheels in a Canadian Foundry

The Methods Employed by the Canadian Pacific Railway Co. to Insure Sound Wheels Conforming to Unusually Exacting Specifications

By C E Gray

MANUFACTURING cast iron car wheels having chilled treads and soft hubs and plates is attended with difficulties not encountered in ordinary foundry work. If the outer part of the wheel is subjected to an unusually high chill to give it the qualities necessary to withstand extremely severe climatic and service conditions, the problem presented to the foundryman is further complicated. This is true of the work in the wheel foundry of the Angus shops of the Canadian Pacific Railway Co., at Montreal, where practically all of the cast wheels used on that system are made.

Owing to the severe winters in the territory traversed by the lines of the Canadian Pacific, the wheels must conform to specifications that are more exacting in many ways than those controlling the manufacture of wheels for many other roads. In order to avoid shelled spots on the tread, the depth of the chill required in the specifications is unusually high. The requirements for the three standard sizes of wheels, including the maximum and minimum allowable depth of pure white iron in inches are as follows:

Normal weight of wheel pounds.	Depth of pure white iron, minimum inches.	maximum inches.
625	½	1
675	$\frac{9}{16}$	$1\frac{1}{16}$
725	⅝	1⅛

It has been found that in order to produce this chill the iron must contain approximately 0.67 per cent silicon, 0.478 per cent manganese, 0.145 per cent sulphur, and 0.287 per cent phosphorus. Pig iron from five to six different cars is used in each mixture to insure uniform results and to avoid any discrepancy in the anal-

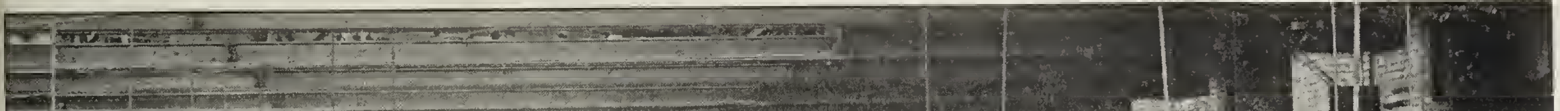
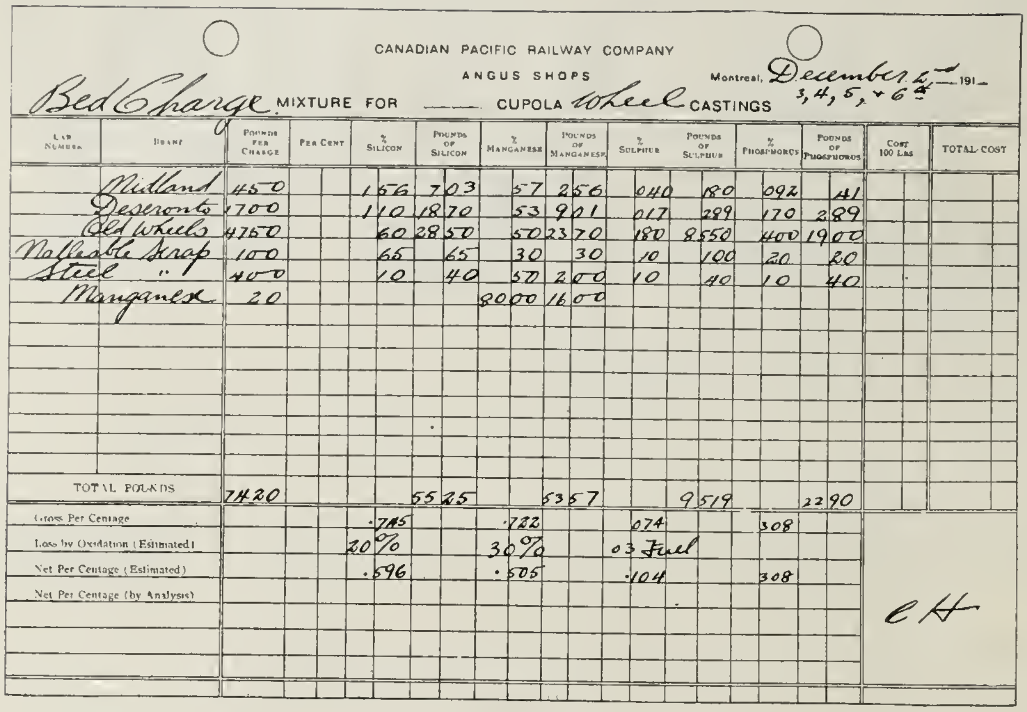


FIG. 1—VIEW OF MOLDING FLOOR IN WHEEL FOUNDRY OF CANADIAN PACIFIC RAILWAY CO



CANADIAN PACIFIC RAILWAY COMPANY
ANGUS SHOPS
Bed Charge MIXTURE FOR ____ CUPOLA Wheel CASTINGS Montreal, December 2nd 3, 4, 5, + 6th 191_

Car Number	Brand	Pounds per Charge	Per Cent	% Silicon	Pounds of Silicon	% Manganese	Pounds of Manganese	% Sulphur	Pounds of Sulphur	% Phosphorus	Pounds of Phosphorus	Cost 100 Lbs	Total Cost
	Midland	450		1 56	7 03	57	2 56	040	180	092	41		
	Deseronto	1700		1 10	18 70	53	9 01	017	289	170	2 89		
	Old Wheels	4750		60	28 50	50	23 70	180	8 550	400	19 00		
	Malleable Scrap	100		65	65	30	30	10	100	20	20		
	Steel "	400		10	40	50	2 00	10	40	10	40		
	Manganese	20				80 00	16 00						
TOTAL POUNDS		7420			55 25		53 57		9 519		22 90		
Gross Per Centage				·745		·722		074		308			
Loss by Oxidation (Estimated)				20%		30%		03 Fuel					
Net Per Centage (Estimated)				·596		·505		·104		308			
Net Per Centage (by Analysis)													

C H

FIG. 2—TYPICAL BED CHARGE FOR CASTING IRON FOR CAR WHEELS

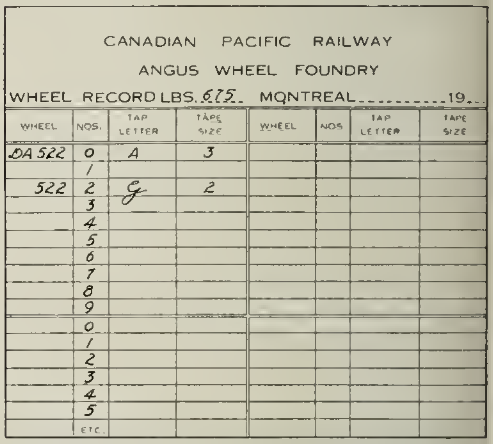
ysis. When charging, great care is taken to place the iron in the cupola so that each charge will enter the melting zone with the greatest uniformity and at as great a distance from the tuyeres as possible. About 3,720 pounds of coke is used in the bed charge.

The first charge of iron is 8,000 pounds and the subsequent regular charges are composed of 925 pounds of coke and 8,800 pounds of iron. Figs. 2 and 3 are reproductions of the standard form on which the materials charged are recorded. It will be noted that the bed charge has lower silicon than the regular charges because there is less oxidation at the beginning of the heat and the impurities of the first charge do not vary appreciably. The wheels cast from the first iron usually tape 2 or 3. In Fig. 3, the percentage of wheel scrap in the regular charge is given as 53.42. Soon after this particular charge was made up the Canadian Pacific secured a large number of cars and wheels from outside manufacturers and consequently the supply of scrap wheels became greater than the demand. A scheme for utilizing this excess of scrap was devised by working out an analysis which reduced the steel and malleable scrap in the charge and increased the percentage of the scrap-wheel iron to 75. This mixture conformed to specifications and did not materially increase the foundry loss. The sulphur content is higher than in many makes of wheels, but service tests have proved that this has no detrimental effect providing the remainder of the mixture is properly made. The following mixtures, based upon analyses allowing for a high percentage of wheel scrap, have proved satisfactory:

Pig iron.	Wheels.	Malleable.	Steel.	Total.
1,700	6,200	500	370	8,770
1,500	5,600	465	350	7,915
3,400	4,100	700	600	8,800
2,500	5,200	450	650	8,800
1,200	6,700	450	450	8,800

The record of the tapping of the cupolas and the distribution of the metal is kept on a tap card similar to that reproduced in Fig. 5. The letters in the first column refer to the taps taken from the cupolas during the day. The figures in the second and third columns represent in inches the depth of the chill on test pieces cast from metal taken from the bull ladle and from the distributing ladles after the metal has been treated. The columns under "Floor Numbers" show the distribution of the metal to the various molding floors. By referring to the key at the bottom of the card, and remembering that the numbers less than 10 are not in code, it is easy to trace the pouring of the metal from each tap. The dashes and crosses appearing above the numbers indicate the amount of silicon or steel punchings added to the mixture, and are explained in the key at the bottom of the card. The number of pounds of manganese and silicon added to the metal in the large or small ladles is shown in the last few columns of the card. It is estimated that about 10 pounds of silicon and five pounds of manganese must be added to the metal in the large ladle to change the depth of the chill 0.10 inch. Additions in the small ladle are made in ¼-pound packages and the steel is added from a measure containing two pounds.

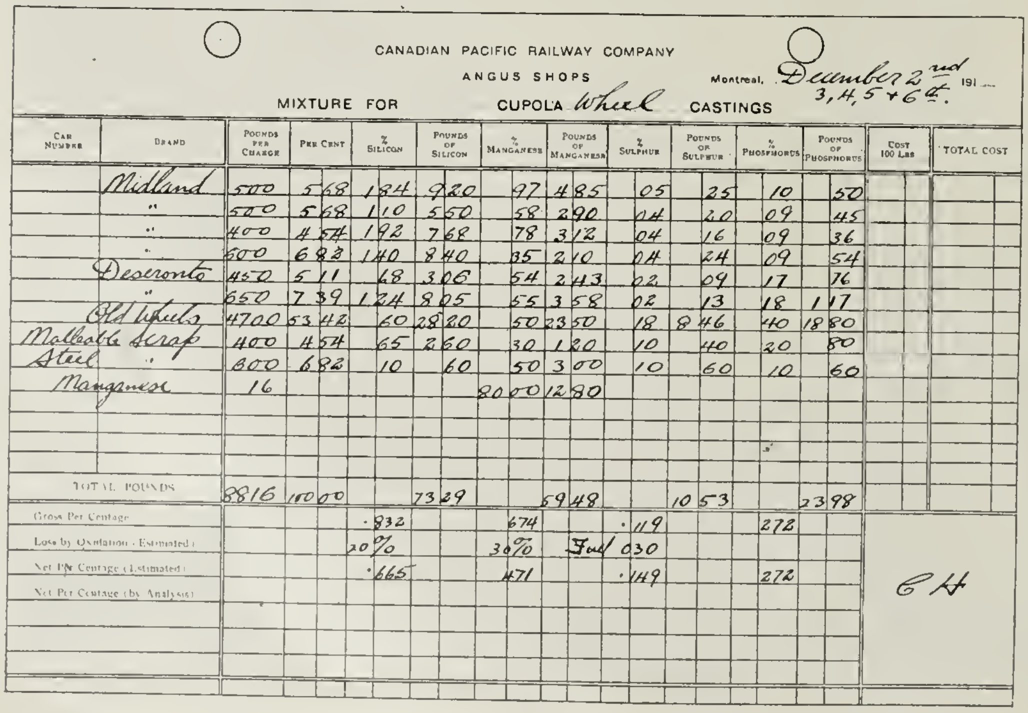
The melting equipment of the foundry consists of two 72-inch Whiting cupolas. Each of these is tapped into an eight-ton mixing ladle operated by an electric motor. The metal



CANADIAN PACIFIC RAILWAY
ANGUS WHEEL FOUNDRY
WHEEL RECORD LBS. 675 MONTREAL ________ 19__

Wheel	Nos.	Tap Letter	Tape Size	Wheel	Nos	Tap Letter	Tape Size
DA 522	0	A	3				
	1						
522	2	G	2				
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	0						
	1						
	2						
	3						
	4						
	5						
	ETC.						

FIG. 4—WHEEL RECORD FROM WHICH TEST WHEELS ARE SELECTED



CANADIAN PACIFIC RAILWAY COMPANY
ANGUS SHOPS
MIXTURE FOR CUPOLA Wheel CASTINGS Montreal, December 2nd 3, 4, 5 + 6th 191_

Car Number	Brand	Pounds per Charge	Per Cent	% Silicon	Pounds of Silicon	% Manganese	Pounds of Manganese	% Sulphur	Pounds of Sulphur	% Phosphorus	Pounds of Phosphorus	Cost 100 Lbs	Total Cost
	Midland	500	5 68	1 84	9 20	97	4 85	05	25	10	50		
	"	500	5 68	1 10	5 50	58	2 90	04	20	09	45		
	"	400	4 54	1 92	7 68	78	3 12	04	16	09	36		
	"	600	6 82	1 40	8 40	35	2 10	04	24	09	54		
	Deseronto	450	5 11	68	3 06	54	2 43	02	09	17	76		
	"	650	7 39	1 24	8 05	55	3 58	02	13	18	1 17		
	Old Wheels	4700	53 42	60	28 20	50	23 50	18	8 46	40	18 80		
	Malleable Scrap	400	4 54	65	2 60	30	1 20	10	40	20	80		
	Steel "	800	6 82	10	60	50	3 00	10	60	10	60		
	Manganese	16				80 00	12 80						
TOTAL POUNDS		8816	100 00		73 29		59 48		10 53		23 98		
Gross Per Centage				·832		674		·119		272			
Loss by Oxidation (Estimated)				20%		30%		Fuel 030					
Net Per Centage (Estimated)				·665		471		·149		272			
Net Per Centage (by Analysis)													

C H

FIG. 3—TYPICAL CHARGE FOR CUPOLA MELTING WHEEL IRON

is poured from these large ladles into distributing ladles carried on trucks which are moved along a narrow gage track by means of an endless cable passing over an electrically driven drum. These small distributing ladles, which have a capacity of about 950 pounds, are then lifted from the trucks by hoists which traverse the molding floors and carry the metal to the molds. The apparatus for handling the metal is shown in Fig. 1. The two mixing ladles and the track for the ladle train are shown at the right of the illustration. The cables suspended over the molding floors control the operation of the hoists, one line of each pair controlling the horizontal movement of the hoist, and the other the raising and lowering of the burden.

Method of Pouring

As shown on the tap card, Fig. 5, about 15 wheels are poured from each tap. The amount of metal run into the mixing ladle at the beginning of each heat is gaged so that each subsequent tap from the cupola will be sufficient for pouring approximately 20 wheels. Some of this first metal is poured into a 50-pound test ladle and from this a chill test piece 1½ inches wide, 2 inches thick and 6 inches long is cast. This piece is solid enough to break by the time the tenth wheel has been poured. From observation of former test pieces the foreman or his assistant is able to judge whether the iron is soft or hard. The metal to be used for the remaining five wheels from this tap is treated with manganese, titanium or silicon to bring about the desired degree of hardness. The fifteenth small ladle is held until another test piece from the mixing ladle has been examined. This piece is solid enough to indicate the character of the iron for the next tenth wheel. The metal for the first 10 wheels of the next tap is treated according to the character of a test piece poured from the fifth small ladle of the preceding tap. This iron had previously been treated to correct faults discovered in a test piece taken from metal in the bull ladle.

A definite system of pouring the wheels on each molding floor is followed. Metal from the first tap is served to the molds at one end of the foundry on one day, and on the following day it is poured at the opposite ends of the molding floors. Five distributing ladles are filled from the bull ladle, and are carried on the ladle train to the heads of five molding floors, where they are lifted by hoists traveling on overhead runways over the molding floors. These hoists carry the iron to the desired molds, where it is poured. The ladles return to the bull ladle, and on the next two trips of the train 10 wheels in the same five molding floors are poured. The metal from the next tap is served to molds in five different molding floors. The distribution of the metal from each tap is clearly indicated in Fig. 5.

TAP CARD

CHILL TESTS				FLOOR NUMBERS																SILICON		MANGANESE		STEEL	
TAP	CUPOLA	SMALL	TEMPERATURE OF IRON	1 20 690	2 19 690	3 20 690	4 19 690	5 21 645	6 21 645	7 20 750	8 20 645	9 20 750	10 20 645	11 19 690	12 19 690	13 19 645	14 19 750	15 19 750	TOTAL	LARGE	SMALL	LARGE	SMALL	LARGE	SMALL
A	1.25	1.20	HOT						59B	48b	30E	27Ł	16L						15						48
B	1.20	1.05	"						38E	27ŁB	6L	150b	49						15						86
C	1.10	1.05	"	349b	50B	26L	1Ł	18E											15						88
D	1.15	1.10	"	49	50	16L	27Ł	38E									B	b	15						92
E	1.35	1.30	"											38E	27Ł	16L	50B	49b	15						120
F	1.20	1.15	"																15	25					80
G	1.10	1.10	"						29b	148E	7Ł	36L	x 50B						15	20					64
H	1.10	1.10	"		B	b	E	Ł	49	38L	27	160	5						15	15					92
I	1.20	1.15	"	167Ł	58E	49b	30B	2L											15	–					104
J	1.20	1.15	"	6	5	4	3	127						Ł	L	0B	9b	8E	15	10					96
K	1.20	1.15	"											27Ł	16L	50B	496	38E	15	10					120
L	1.15	1.10	"						Ł	7LB	60	59b	x 8E	2	1		4	3	15	10					100
M	1.20	1.20	"						27Ł	16L	50B	49B	38E						15	10					72
N	1.30	1.25	"	78E	69b	504	3L	2Ł	1										14	15					92
O	1.25	1.20	"	78	69	50	14L	23Ł						E	b	B			15	25					76
P	1.15	1.15	"											7Ł	6L	50B	149B	238E	15	20					96
O	1.10	1.15	"						0B		ŁL		bE	27	16	5	49	38	15	25					64
R	1.25	1.20	"	0B	L	Ł	E	b	269		147		358						15	20					40
S	1.25	1.20	"	5B	16E	27Ł	38L	490								B			15	25					80
T	1.25	1.20	"											258L	1470	369			11						48
TOTAL																									

X = ½ LB. POWDERED SILICON
— = 2 LBS. STEEL PUNCHINGS
O = 10TH LADLE
L = 11TH LADLE
Ł = 12TH LADLE
E = 13TH "
b' = 14TH "
B = 15TH "

NO TONS IRON	
" " COKE	
BLAST ON	9:30
FIRST IRON	10:15
BLAST OFF	4:15
LAST WHEEL POURED	4:35

FIG. 5—TAP CARD SHOWING DISTRIBUTION OF METAL AND LADLE TREATMENT

After a molder has poured five wheels he is permitted to shake out the flasks. The castings are cleaned as much as possible by scraping and hammering, and are moved to the ends of the molding floors for further cleaning. The gates and sprues are knocked off and the center cores removed, after which they are placed on a hot-wheel train and carried to the annealing pits.

The 64 annealing pits are arranged in four rows of 11 and two rows of 10. Each pit, with the exception of two experimental ones, is lined with fire brick and has a capacity of 25 wheels. On account of the depth of these pits and because the foundations are on hard clay, it has been necessary to connect up each pit with a 7-inch pipe to provide ventilation.

An overhead traveling crane equipped with two hoists spaced 4 feet 6 inches apart to conform with the distance between center lines of the rows of pits, is used to handle the hot wheels. The crane hooks are equipped with ingenious tongs which grip the walls of the bore of the wheel. When the wheel is lowered into the pit, the weight of the tongs after the load is taken off is sufficient to cause them to fold up, thereby releasing the grip on the wheel. The points of the tongs which come in contact with the wheel bore are forged with angular teeth to prevent slipping.

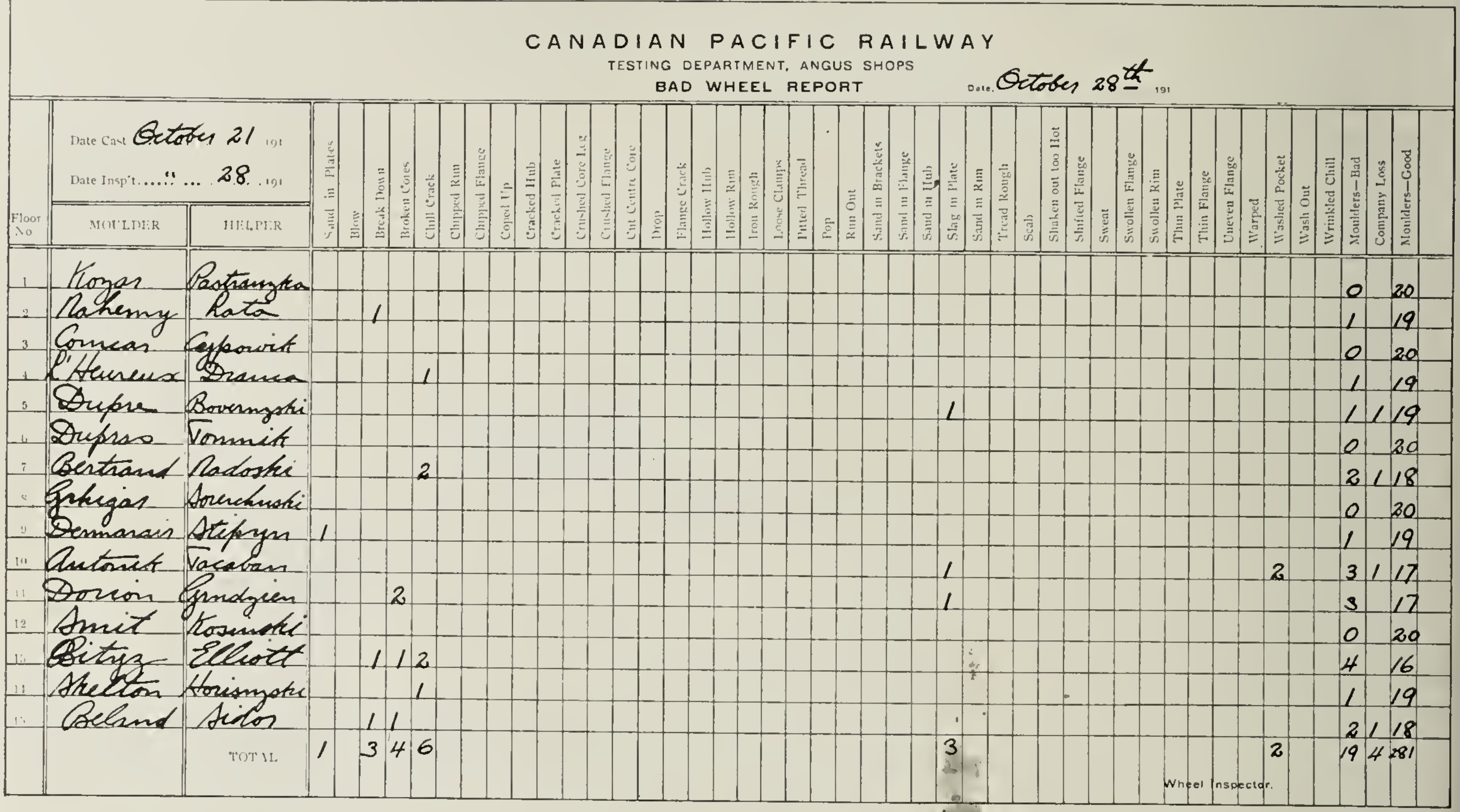
How Internal Stresses are Discovered

The wheels are left in the annealing pits for four days, and after they are removed from the pits they are allowed to stand over night to allow them to cool sufficiently for the final operation which cleans the wheels.

The purpose of the annealing is to reduce the strains set up in the plates by the chilling of the treads. A thermal test has been established to check the annealing operations and to insure the elimination of stresses in the plates. The test consists of pouring a band of metal 1½ inches thick and 4 inches deep around a cold wheel. If the wheel cracks across the tread or through the plate in less than two minutes, the wheel, and all others from the same mixture of metal, are rejected.

The effect of the annealing process depends upon the temperature of the pits and the time the wheels are subjected to the heat. A small test bar placed in one of the pits for only six hours will show a white fracture when broken, but will be so soft that it can easily be cut with a lathe tool. As a matter of fact, the temperature of the annealing pits is maintained at about 1,700 degrees Fahr. After three or four hours the temperature falls 300 or 400 degrees, but on account of the heavy cross-section of the wheel tread, no noticeable softening occurs. The Roberts-Austens diagram shows that when 1,292 degrees Fahr. has been reached, there is no softening because the martensite and cementite, the hardening elements, are then stable.

Tests made on annealed and unannealed wheels under a drop testing machine showed that 35 per cent more blows are required to break annealed wheels than are necessary to break unannealed ones. The test wheels are selected from a wheel record similar to that shown in Fig. 4. This shows the consecutive numbers of the wheels together with the tap letters and the tape sizes. The inspector selects two wheels indicating the greatest shrinkage (smallest tape size) and having the least weight. One is used for the thermal test and the other for the drop test. Another wheel having the greatest tape size and weight is broken and inspected for the depth of chill. The results of these tests are recorded on a daily summary sheet, and in nearly every case, each failure can be traced to a definite cause. Fig. 6 is a reproduction of the daily report of wheel failures made by the inspector. It will be noted that the defects caused by poor molding are charged to the molder who performed the poor work, and that failures due to circumstances beyond the control of the molders are charged to company loss.



CANADIAN PACIFIC RAILWAY
TESTING DEPARTMENT, ANGUS SHOPS
BAD WHEEL REPORT
Date, October 28th 191

Date Cast October 21 191
Date Insp't " 28 191

Floor No	MOULDER	HELPER	Sand in Plates	Blow	Break Down	Broken Cores	Chill Crack	Chipped Rim	Chipped Flange	Coped Up	Cracked Hub	Cracked Plate	Crushed Core Leg	Crushed Flange	Cut Centre Core	Drop	Flange Crack	Hollow Hub	Hollow Rim	Iron Rough	Loose Clamps	Pitted Thread	Pop	Run Out	Sand in Brackets	Sand in Flange	Sand in Hub	Slag in Plate	Sand in Rim	Tread Rough	Scab	Shaken out too Hot	Shifted Flange	Sweat	Swollen Flange	Swollen Rim	Thin Plate	Thin Flange	Uneven Flange	Warped	Washed Pocket	Wash Out	Wrinkled Chill	Moulders—Bad	Company Loss	Moulders—Good
1	Kozar	Pastranzka																																										0		20
2	Nahemy	Rota			1																																							1		19
3	Comcas	Cezpowik																																										0		20
4	L'Heureux	Drama					1																																					1		19
5	Dupre	Bovernyski																										1																1	1	19
6	Dupras	Tonnik																																										0		20
7	Bertrand	Nadoski					2																																					2	1	18
8	Gekigas	Sorechuski																																										0		20
9	Demarais	Stepryn	1																																									1		19
10	Antonik	Tocaban																										1													2			3	1	17
11	Dorion	Grndzien				2																						1																3		17
12	Smit	Kosmoski																																										0		20
13	Bitys	Elliott			1	1	2																																					4		16
14	Shelton	Horismski					1																																					1		19
15	Beland	Sidor			1	1																																						2	1	18
		TOTAL	1		3	4	6																					3													2			19	4	281

Wheel Inspector.

FIG. 6—REPORT OF TEST DEPARTMENT ASSIGNING CAUSES OF DEFECTIVE WHEELS

This record has proved of great benefit in producing better wheels and eliminating carelessness among the molders. A further check upon the performance of the wheels is maintained by a strict account of all failures in service, and a record of the mileage made by each wheel. By assembling the information contained in these reports it has been possible to work out the percentage of shelled spots, flats, broken flanges, cracked plates, etc., for each size and type of wheel. These statistics have been an important factor in the development of better methods in the wheel foundry.

The broken flange problem has been receiving considerable attention during the last few years, because it is believed that many derailments have been caused by defects of this kind. The heating of the wheel due to the application of the brakes and the cooling of the flange in snow may be a contributing factor to flange failures, but the tendency to increase the weight of the cars without adequately increasing the weight and strength of the wheels has been one of the most important causes.

In an endeavor to remedy trouble of this kind the Canadian Pacific designed an 880-pound wheel having a strengthened flange which would just clear the frogs. The cross-section of the tread was so large that sufficient chill was not produced with the standard mixture and it was found that if the analysis were changed to suit this condition, the Master Car Builders' regulations would be violated. To overcome this difficulty, nickel-chrome pig iron was used, the mixture containing 0.98 per cent silicon, 0.81 per cent manganese, 0.02 per cent sulphur, 0.05 per cent phosphorus, 0.98 per cent nickel and 2.40 per cent chrome. It was determined that in this combination there would be no loss in the nickel and about 2 per cent in the chrome. When an excessive chill was indicated by the test piece, titanium was added with good results. The wheels made from this nickel-chrome mixture were placed in service under locomotive tenders where they would be subjected to about 30 per cent heavier brake pressure than under a coal car, and would have a mileage exceeding that of wheels under a coal car by at least 300 per cent. The results of these service tests showed that the wheels compared favorably with other satisfactory types of wheels then in use, but for various reasons they were not adopted.

This experiment showed that nickel and chrome have an important influence of the crystallization of the iron and on the tendency for the thread to shell out. This was indicated by the fact that it was necessary to reduce the percentage of steel and scrap to secure the desired carbon content. The mixture was composed of 22.46 per cent pig iron, 6.25 per cent steel, 50.8 per cent scrap wheels, 6.93 per cent Mayari (nickel-chrome) pig iron and 6.25 per cent malleable iron.

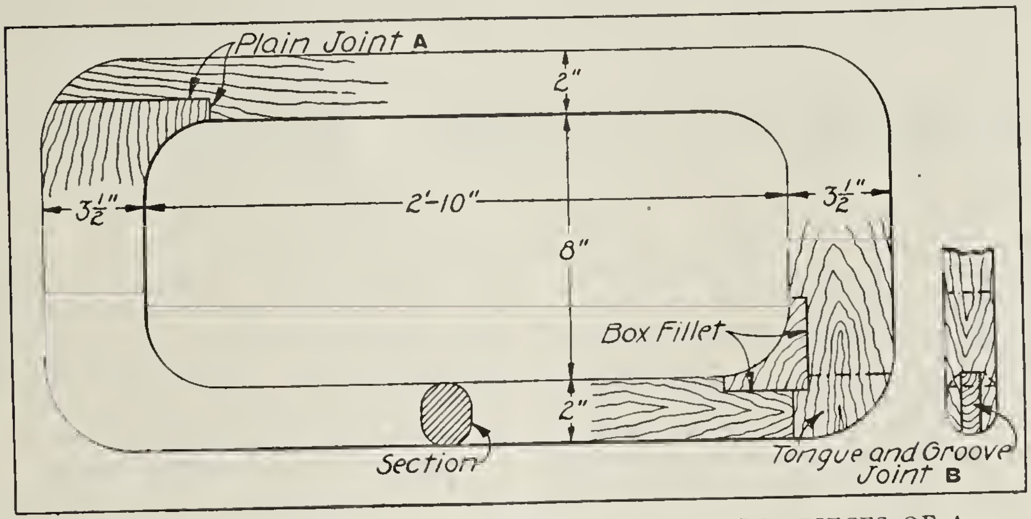
The Influence of Design on the Cost of Patterns

By M. E. Duggan

The article in the January issue of *The Foundry* by John Leafstrom is interesting and instructive. He shows in a clear, practical manner how a machine detail which, if handled in a careless manner becomes complicated and costly, may be made simple and inexpensive by means of an ample knowledge of patternmaking and molding practice.

What effort is being made to insure the foundries of today against the embarrassment caused by improperly made patterns? Frequently complaints are heard that machine parts are so complicated in their design that the patternmaker is at his wits end to know how to construct a pattern which will be practical to mold and yet remain within a reasonable limit of cost. In the pattern shop, foundry and machine shop improved methods are being studied and worked out every day, but in too many cases, this progressive study is being made without a sufficient amount of co-operation between the three departments. The foundryman, when impressed with the advantages of co-operation, is dubious as to the results obtained. Perhaps co-operation between the patternmaker and the foundryman has meant little to him. In too many cases, the draftsman has attempted to carry out his ideas of co-operation in a clean and comfortable office rather than in the foundry. This has led the men in the foundry to underestimate the practical value of the draftsmen's opinion. They feel that his information is drawn from other men in the office whose ideas are not gained from actual contact with founding problems.

The draftsman who watches the process of molding unusual or exceptional castings in the foundry not only discovers facts of value to himself but also impresses the foundrymen with the fact that he is interested in their problems. This leads to an appreciation of his efforts which is a long step toward co-operation. The draftsman who makes a practice of frequently visiting the molding floor will soon break down the prevailing opinion among molders that many of the shirt-sleeved office draftsmen spend their time over drafting boards utilizing two or three days for fancy drawings to illustrate patterns which could be clearly sketched for all practical purposes in a few hours' time.



INEXPENSIVE AND EXPENSIVE METHODS OF JOINING PIECES OF A SIMPLE PATTERN

The cost of a pattern in many instances can be attributed to the lack of mechanical judgment displayed by the patternmaker. An example of an inexcusable waste of time and money is indicated in the accompanying illustration, which shows a pattern for one of two steel castings ordered from a certain foundry. The shape and dimensions were the same in both castings except that one was slightly longer than the other. This difficulty necessitated the making of two patterns. Owing to the large amount of work in the pattern shop of this foundry one pattern was sent to a jobbing pattern shop, the other being made in the company's shop.

The patternmakers in the foundry pattern shop cut and fastened the parts of the pattern as shown in the accompanying illustration at *A*. The joint was easily and quickly made at a minimum cost. The pattern thus constructed was satisfactory in every respect and could have been used for from one to 25 castings. The parts made in the jobbing shop were jointed as shown at *B*. The end pieces were grooved and the side pieces were tongued to form a joint and the inside radius at the corner was formed by a box fillet. On account of the extra labor involved in making this fancy joint the pattern was not delivered on time and the making of the casting was delayed 24 hours.

This example is not presented as a criticism of the method employed by the jobbing pattern shop. The case however, indicates how easily the lack of judgment and co-operation may result in making patterns unnecessarily expensive. The patternmaker who can construct his patterns simply and yet make them strong enough to meet the demands of molding, is really promoting the spirit of co-operation for which all foundrymen, patternmakers and machine shop foremen are so eagerly striving at the present time.

Electric Resistance Alloy

All alloys for electric resistance elements containing substantial quantities of nickel and chromium are covered by what is known as the Marsh patent, No. 811,859, issued Feb. 6, 1906, and which was sustained in a recent suit. The Marsh alloy contains approximately 80 per cent nickel and 20 per cent chromium, or 80 per cent nickel, 18 per cent chromium, and 2 per cent aluminum. Alloys consisting of iron, 70 per cent, and nickel, 30 per cent; iron, 80 per cent; nickel, 15 per cent, and manganese, 5 per cent, have a life of only one two-hundredth of the Marsh alloy when used as resistance elements.

When 10.68 per cent chromium is added to 89.32 per cent nickel, the melting point of the latter is reduced 15 degrees Cent. Twenty per cent chromium reduces the melting point of nickel 30 degrees Cent.

The Use of Chills in Producing Sound Castings

How to Control the Action of Cast Iron, Malleable Iron or Cast Steel as It Passes From the Liquid to the Solid State

FOUNDRYMEN are beginning to realize that too little attention has been paid in the past to a study of the behavior of metal as it cools in the mold. The gating of castings, the use of chills, and the methods of pouring employed have been the results of experience in which the effects of rough experiments have been the deciding factors as to what is good or bad practice. As a rule, foundrymen have considered their investigations completed as soon as they hit upon a plan of gating and pouring which produces satisfactory castings. When a different type of pattern comes into a shop, the experimental work must be repeated in all its details.

During the past decade, a number of foundrymen have delved into the subject of controlling the action of cooling metal with unusual thoroughness. The results of the investigations of these men have been given to the foundry industry through the medium of trade journals and papers read at the meetings of foundrymen's associations. The latest discussion of the subject took place at the December meeting of the Birmingham branch of the British Foundrymen's Association. The subject, "The Functions of Feeders and Denseners," was introduced by papers dealing with the use of chills in cast iron, malleable iron and cast steel practice. Abstracts from these papers follow:

Control of Cooling Metal in Cast Iron Work

By J J Howell

IN a paper read before the November, 1916, meeting of the Birmingham branch of the British Foundrymen's association, J. E. Fletcher assumed that feeding is necessary to facilitate the escape of occluded gases in the molten metal. The writer believes that if the gases follow a known law and converge to the center towards the mother liquor, feeding with a rod would help the gases to escape. However, if Mr. Fletcher means to convey that gases are the sole cause of cavities, and that if the gases are eliminated from the metal, the cavities will not occur, it is believed Mr. Fletcher is wrong. With or without gases, feeding is necessary for the production of sound castings of great bulk. Cavities are formed in castings by occluded gases, and there are also shrinkage cavities due to the presence of an impoverished mother liquor. This can only be rectified by keeping in touch with the mother liquor and feeding into it new iron that will supply it with the necessary material for building up a tight crystalline mass.

Why Feeding is Necessary

To understand why feeding is necessary, and how to feed properly, it is imperative that we should have some knowledge of the changes which take place in cast iron when passing from the liquid to the solid state. If cast iron, after being poured into the mold solidifies without any change taking place, feeding will not be necessary, for it is an accepted fact that cast iron in the molten state is a homogeneous mass with all its constituents in solution, and if quenched in that condition, becomes a hard, white, crystalline mass. Under commercial conditions, cast iron is rarely cooled as quickly as this; therefore the elements are not trapped in solution, but time is allowed for them to separate out. Let us imagine that a large mold has just been poured. The metal in the mold may be considered a saturated solution of carbon, silicon, sulphur, phosphorus and manganese in iron. Cooling commences at once, all faces of the mold and cores acting as cooling surfaces. The liquid iron gives off heat waves which are conducted away by the cooling surfaces. The crystals that first freeze out are carried along with the heat waves, and arrange themselves at right angles to the cooling surfaces. The primary crystals are richer in iron than the crystals that immediately follow, and if the first crystals carry pure iron, the molten iron left behind becomes richer in impurities. As the temperature falls, other crystals freeze out, taking with them a big percentage of the iron left. If this process is repeated for some time, the iron which remains in the molten state for the longest period, termed the mother liquor, will become a concentrated mass of impurities. This is where feeding plays its part and if new, clean metal is fed to the impoverished mother liquor, from time to time, it can meet all the demands made upon it by the progressive crystal formation. If this operation is not properly performed, the impoverished mother liquor is unable to supply sufficient crystals to give a solid compact mass. The result is either a large cavity, or a series of small ones, or a loosely packed mass of large crystals giving a very weak casting.

The feeding of large and bulky castings is of great importance, for the great length of time taken in cooling down means a longer period for crystal growth, and incidentally, a weaker casting. Professor Turner has said that the strength of a large casting per unit of area is somewhat less than that of a small one, since the closeness of grain is usually, though not always, associated with increased tenacity. Shop practice proves this to be true; there is a density or hardness that gives the best results. The greatest strength is associated with small crystals which have not arrived at the brittle stage, and it is up to foundrymen to determine the proper degree of density for their own particular work. Having determined the density, they should be sure that they do not upset it by improper feeding.

Design Must Eliminate Sharp Angles

An aspect that should be considered in the production of castings is that of design. The draftsman should know that if anything happens during the cooling to affect the growth of the crystals, or to cause them to take a contrary direction, such action gives rise to a plane of weakness and that, therefore, it is very important, in large castings where strength is required, that there be no sharp or recurring angles, as these must certainly lead to planes of great weakness. The greater mass of metal in such corners is the last to cool, and the crystals which form at right angles to the cooling surface are disturbed by butting up to each other, resulting in a plane of weakness.

It often happens that castings which pass all the mechanical tests satisfactorily fail when subjected to steam or water pressure. Such failures are invariably caused by faulty crystalline formation which might have been avoided by properly designing the casting. It is of vital importance that designers understand the feeding problem, so that all lines which adversely affect the crystal flow can be eliminated. Irregularity in design should also be avoided as far as possible, for it is obvious that the thinner metal is the first to cool and draws on the reserve of the molten section, with the result that either a fracture must occur or the heavier section will be a spongy and segregated mass unless specially treated.

Problems Facing Foundrymen

However, the designer is not able to remove all the ills that beset foundrymen. Local heavy sections, thin walls joining up to strong ones, and heavy bosses placed in impossible positions to feed are conditions the foundrymen must face. In such cases the careful application of chills or deneseners is of value. The changes which take place during the cooling of cast iron are not instantaneous; they are chemical changes and require an appreciable time to accomplish. The chill is thus allowed to have a marked effect, a chill applied to a heavy section being a much better conductor of heat than the sand of the mold. It carries away the heat from the thick part of the casting much faster than the sand from the thinner section, thereby giving a more uniform growth. Assuming that the metal used is suitable for the work in hand, the whole question of perfect crystallization resolves itself into the rate of cooling.

Parts of Castings Not Uniform

F. J. Cook, in a paper recently published, says it is a well-known fact to metallurgists and foundrymen that the physical properties of most cast metals, such as the size of crystals, hardness, coarseness of grain, strength, etc., are greatly influenced by the rate of cooling from the molten to the solid state, and in none is this more freely shown than with cast iron; in fact with this metal it must only be considered second to, and in some cases of equal importance to the chemical composition of the metal itself, when considering it on the lines of its tensile strength. To prove this statement by ocular demonstration, Mr. Cook had a bar cast in the shape of a wedge, tapering from ¼ x 3 inches at, one end to 6 inches square at the other and being 2 feet long. This was cast in a dry sand mold from metal fairly low in silicon and total carbon, such as would give strong castings of 1¼ to 2 inches thick. It was cast on end with the thin end down and was left in the mold until properly cooled. When the bar was broken, the fracture ranged from close-grained white iron at the thin end, to open grain with large crystals in the center, and metal of very little cohesion at the large end. To demonstrate further the difference in various parts of the bar, hardness tests were taken at 5 inches from the thin end, 3 inches from the thick end, and halfway between. This hardness was taken by the drill method, the results being 70, 56 and 40, respectively. The differences in hardness and fracture show what is likely to happen in the various castings mentioned if they were all cast from the same metal. It is also possible for the differences to occur in the same casting, if badly designed, with abnormally thick and thin parts.

If a section similar to that used in Mr. Cook's experiment occurs in a casting, it is obvious that a similar result will be obtained unless the casting is specially treated. Chilling is perhaps the easiest and least laborious method of doing this. Care must be exercised to see that the chill is not thick enough to cause a chilled surface on the casting, but just thick enough to densify the crystal formation, to give a good wearing surface which is not too hard for machining operations.

Preparation of Chills

In preparing chills for a flat surface, a pattern may readily be cut to the desired length, width and thickness. If the surface is an irregular one, expense of a complicated pattern can be saved by pressing a piece of pliable clay on the pattern till a good impression had been obtained. The clay can then be cut to the thickness required and left on the pattern all night to stiffen. A good pattern for the chill may be obtained in this manner. When molding these chills it is good practice to cast a couple of sprigs in the back, or a rod, according to the weight. These assist in securing the chills safely in the mold. If the chills are to be used on the outside of the mold, they should be placed on the pattern and rammed up in the usual way, but if they are to be used in cores, the molder should be sure that clearances have been allowed so that the chill and the core iron do not butt together, thereby hindering the normal contraction.

Use of Chills in Malleable Iron Practice

By A Fraser

IN using chills in malleable work, the main points to be remembered are that this iron has a very high liquid shrinkage and a narrow range of fluidity varying considerably with the composition. It also has high linear contraction which varies slightly with the composition, as the castings should be of white iron throughout if success is to be attained after heat treatment. Those three features in the cooling of malleable iron present difficult problems which may be most easily solved by the judicious use of chills. Although these devices have many uses, one of their chief functions is to eliminate the local liquid shrinkage cavities which are usually found in the weighty sections of a casting, which take the form either of a hollow in the interior, or depression in its surface. This defect can be overcome by placing a gate or feeding head on the sections likely to be affected in this manner, but where there are a number of such places on the same casting, the molten metal and additional work required to procure a sound casting is excessive and does not lend itself to economical production. The service required from chills in a cast of this kind is to cool the sections on which they are placed so rapidly that all liquid shrinkage will take place before the metal in the gate and the parts of the casting connecting it with the heavy section has solidified.

When chills are used, care should be exercised to have them of the proper size and weight, because if the one nearest to the gate or feeding head is too large, it will check the flow of molten iron to the parts beyond it and cause cavities or sponginess even in the thin sections. When a number of chills are used, those nearest the gate should not be so small that the flow of iron passing them can raise their temperature before the mold is filled, thus impairing their efficiency as heat conductors at the required time.

Another defect frequently found in malleable iron castings which often may be rectified by chilling, is called in foundry parlance a "sear". This is a hot crack resulting from linear contraction on adjacent sections cast at angles to one another while their junction is still in a semi-rigid state and has yet to attain sufficient cohesion to overcome the resistance of the mold to their passage. It usually occurred where the sections are at acute angles to one another and is found at the apex of the interior angle. In appearance it resembles a hair, varying in thickness, laid irregularly on the casting. Chills should not be used indiscriminately to rectify this fault as the addition of a radius to the pattern usually overcomes the difficulty, provided the radius does not result in such an accumulation of heat at that point that liquid shrinkage was encountered. Another use for chills is in the prevention of flying, or the breaking of castings during the later stages of their cooling, or while undergoing the annealing process. This common trouble is the result of the different rates of cooling and varying time of contraction in the different sections of the casting. The method commonly adopted to relieve the stresses causing such breakages is to transfer the casting while still at a high temperature into a muffle and cool very slowly. In case such treatment cannot be given, chills may be used to equalize the cooling. Castings may thus be produced successfully without slowly cooling them.

Protect Surface of Chills

A chill on which the metal impinges and becomes at once stationary should be coated only with a substance with a low volatile constituent; otherwise, with a thin-sectioned casting, blowholes or a depression will occur on the surface. A chill subjected to considerable heating before the mold is filled should be coated with a substance containing a much higher volatile constituent so that it is protected for some time by a film of gas. On a chill which is weighty enough to stand up to the work expected of it, a coating of black oxide of iron, formed by heating to a good red color, has been found to afford sufficient protection. With this coating the chill must not stand too long and collect moisture, as the red or hydrated oxide is, of course, abhorrent to molten iron. Iron which has a clean metallic surface should not be used for chills without previous coating because of the danger of cementation to the castings. Gray iron chills which become heated to redness should not be used many times, as, apart from their liability on repeated heatings to increase in volume and become distorted, small fissures containing gas may develop in the iron. With an increase of temperature this gas expands and is quite likely to cause very serious blowholes.

Chills must be placed so that their properties will produce the desired effect. All chills, if left standing for some time before casting in green sand or partially dried molds, collect moisture, and if free egress is not allowed a faulty casting is obtained. If a chill is placed with its face in a perpendicular position or at a gently rising angle, this trouble is almost eliminated, as the metal rising in the mold drives the vapors before it. Horizontally placed chills, either on the top or on the bottom of the casting, are not as trustworthy in their action, as vapor is frequently entrapped at the surfaces, especially in the case of those at the top of the mold.

Heading, Gating and Chilling Steel Castings

By A Fraser

FOUNDRY practice in steel casting plants has a number of features in common with the procedure of making castings in a malleable shop. There are, however, differences in detail which must be considered. Steel is cast at a high temperature, has a narrow range of fluidity and freezes rapidly. It also has a high linear contraction immediately after passing the pasty or semi-rigid state in conjunction with its lack of cohesion while in that state. The value of chills on steel castings is almost negligible excepting on thin-sectioned and small light castings. On this class of work their use is essential to economical production. The rapid freezing of the steel, however, imposes a short limit on the chill's effective time of action; therefore, to get the maximum effect in the short time at disposal, the chill must be considerably larger than if it has to produce the same effect on a malleable iron casting. The high casting temperature caused a liability to cementation of the casting and chill if the latter is not weighty or had any sharp projections.

Occasionally castings are required which need treatment with feeding heads or chills, but on which it is impossible to get feeders in the proper position or to apply external chills of sufficient weight to be effective. The method adopted to overcome this difficulty is to insert pieces of clean wrought iron into the sand of the mold, allowing them to project into the section where the cooling has to be accelerated. This is a practice which cannot be recommended, as, apart from the danger of non-cementation of the steel and wrought iron and weakening of the casting, the occluded gases in the pieces of wrought iron very frequently cause sponginess and blowholes in their locality.

One of the most useful functions of chills in relation to the casting of steel is in reducing the frequency of hot cracks. The immediate cause of these cracks, which are common in even small castings, is the resistance of the mold, at its angles and projections, to the inward movements of the different parts of the casting. The cracks occur at the weakest part of the casting in the locality where the tension exists. Those weak places are usually found where there is an accumulation of heat or where the thickness of the section is increased. Easing the resistance of the mold to obviate this fault is no doubt the best method in castings of large size and weight. Also, the casting of connection or tie bars is good, although it increases the consumption of metal and adds to the finishing costs. Where large numbers of castings are cast in a few minutes, and the crack occurs a few seconds after pouring, the first method is impossible, and the second is not economical when the castings are light. The chill appears to be the best remedy in a case of this nature. It need not be as large as if intended to meet liquid shrinkage, as it is doing effective work until the steel in contact is at the close of the semi-rigid state.

he feeding head is an essential ature on all heavy steel castings, nd in nothing does the skill and xperience of the foundryman show greater advantage than in the com- arative size of the head and the asting to which it is attached. The ize of the head should be regulated y the design of the casting, the posi- ion of the pouring gate, the distance o which feeding action is required nd the relative temperatures of the nold and head. The position of the ouring gate should be considered vith the object of finding whether the ntering metal will heat the mold so hat a local slow cooling will ensue; lso whether the stream of metal will flow over parts which naturally retain their heat longest, and thus further retard their cooling. To some degree, the height of the head is controlled by the range of feeding needed. Hydrostatic pressure is required to force the viscous steel into the last of the places where cavities are likely to be formed on cooling. To avoid abnormal height, the number of heads should be increased. It must be understood that with castings which have large surface areas as compared with their bulk, such as a 1-inch square bar, the range of feeding is very limited, even with a head of unreasonable height. If the mold proper is hot and the head mold cold at casting, the head should be comparatively large, because it has to supply fluid metal to a more slowly cooled casting. If the head mold is at a good temperature a much smaller head can be used. The shape of the head is probably the greatest factor in its efficiency; and a large surface area is its greatest enemy. Every effort should be made to keep it as compact as possible. A fairly deep rectangular form has been found to give excellent results.

Proper Method of Attaching Heads

Heads which are correct in size, form and all other essentials, often are made ineffective because they are improperly attached to the casting. The center of the body of the head should be as nearly as possible immediately over the inlet to the casting. The bottom of the head should also be as close to the casting as is compatible with a perfect mold. If those conditions are complied with the connection between the two is short and compact, and is kept open until the casting's demand for metal has been satisfied. If these two bodies of metal are kept further apart, a connection of much larger sectional area is required; otherwise strangulation takes place and the large head is rendered useless.

Varying Strength in Different Parts of a Large Casting

By W. J. Keep

Question:—We make large power presses, punch presses, gate shears, bulldozers, etc., in which very large sections are used. It has been our experience that it is impossible to prevent the cast iron in these large sections from becoming coarse grained and spongy, with occasional hollow places in the center. We use iron containing about 1.50c per cent silicon. We would like to know if tests have been made and published showing the strengh of cast iron in the various parts of a casting. It seems evident that the strength of the iron near the surface will be much greater than it will be in the center.

Answer:—In Volume XXV of the Transactions of the American Society of Mechanical Engineers, page 884, the subject of varying strength in parts of the same casting is treated at considerable length. One experiment made at the plant of R. D. Wood & Co., is illustrated herewith. The large square represents the end of a block of cast iron, 9 inches square and 18 inches long. It analyzed as follows: Total carbon, 2.84 per cent; graphitic carbon, 0.60 per cent; combined carbon, 2.24 per cent; silicon, 1.10 per cent; phosphorus, 0.34 per cent; sulphur, 0.09 per cent, and manganese, 0.49 per cent.

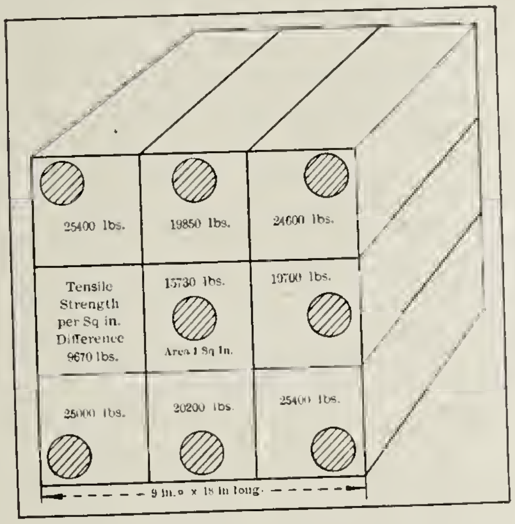


DIAGRAM OF STRENGTH OF CASTING

This block was planed into nine parts and from eight of these were turned test bars of 1 square inch area. The tensile strength of each is given in the illustration. The corner is 9,670 pounds stronger than the center and the corner is 5,000 pounds stronger than the middle portion of the side. This is also shown by compression tests of ½-inch cubes taken at each ½-inch in depth from a 3½-inch square test bar. The center of the side is 2,810 pounds stronger than the center of the casting. It is upon this truss-like distribution of close grain that we depend for strength. The strongest portion of the test bar is its surface. If a hole were bored lengthwise through a test bar, it would not greatly decrease the strength of the bar.

In pouring castings of large section, a feeding head is provided and by churning and feeding liquid metal spongy spots are removed. Chills are placed on inaccessible parts to cause the metal to set as soon as that at the surface. The silicon and phosphorus are kept as low as possible so that the metal will set rapidly and all over at the same time. This also is done so the grain may not be coarse. If you wish a piece to appear of large section, cast it with a core, which would make it as strong a section as if cast solid. The pattern should be of the same thickness in every part and it is often necessary to uncover some part as soon as the iron is set so it will cool as fast as others. Keeping in mind a truss construction with every part the same thickness, you can make a sound casting as strong as you wish in every part and not obtain a coarse grain.

Production of Bauxite in 1916

The production of bauxite in 1916 was 425,359 long tons, which had a value of $2,297,825, an increase of 43 per cent in quantity and 52 per cent in value over 1915. Bauxite is the ore from which aluminum is smelted and the most notable increase in production for the whole United States was made in Georgia and Alabama. In 1915 the production of bauxite in these two states was 25,008 long tons, which was increased to 46,410 tons in 1916, a gain of 86 per cent. The production in Arkansas and Tennessee was increased from 272,033 long tons in 1915 to 378,949 long tons in 1916, a gain of 39 per cent. This increase can be attributed to the development of the well-known deposits in Arkansas.

A process for making uranium oxide has been patented by Charles L. Parsons, which consists of mixing thoroughly pulverized charcoal, sodium uranate or other alkaline uranate with fine-grained salt (NaCl) in the proportions of about 20 parts uranate, 1 part charcoal and 35 parts salt. Fusion of the mixture converts the uranate into oxide of uranium. The fusion is washed with a 3 per cent solution of sodium hydroxide and then with water. It is then digested with water and afterwards washed with an acid solution, preferably a solution containing from 3 to 5 per cent of hydrochloric acid which removes the impurities. The oxide then is dried.

British Foundrymen's Association

The annual report of the British Foundrymen's association, presented at the fourteenth annual meeting in London on June 23 shows a total membership of 1021 against 965 last year. The council reported steady progress in spite of the war, the various branches having done excellent and valuable work for the foundry trade. Many interesting papers were presented and discussed, and visits to various works have been much appreciated by the members. The sum of $1750 was invested in war loans. Regret is expressed in the report at the death of Herbert Pilkington, M.I.C.E., M.I.M. E., the second president of the association. It is remarked that "Mr. Pilkington gave most valuable assistance from the beginning of the association and by his organizing ability made his mark on the work and conduct of the association".

With regard to the war, many members are serving their countr and several have laid down thei lives. "For those still at the fron we wish a happy return at an earl date, and for those who will neve return we give out lasting gratitude,' the official report reads.

A presentation in recognition of hi former presidency was made to W Mayer. J. Ellis delivered the presidential address. Apart from thes items, the business was formal, th war preventing once more the more elaborate program customary in peace times. The progress of the association is encouraging.

Repairing Cracks in Steel Castings Electrically

By B W Bowers

THE process of welding cracks in steel castings electrically, has been a subject of considerable discussion among foundrymen, owing to difficulties resulting from improper methods of procedure. For the benefit of apprentices or beginners in this line of work, the following suggestions will prove of value.

It is common practice among many welding operators, to quickly weld a crack in a casting, with one application of the arc, using a higher amperage than necessary, disregarding the proper size and analysis of the filling-in material. The first problem to be considered is the amount of current applied to the casting, which in many cases is entirely too high. Many operators believe that with a large arc, 500 to 600 amperes, they can quickly melt, puddle and cover up a defect, without causing any chemical harm, when in reality, this excessive heat burns out the life of the metal, leaving the weld in a porous and brittle condition.

Cracks in castings should not be treated as shrinkage, but care should be exercised, and due consideration given to the expansion and contraction of the metal adjacent to the crack.

Completing the welding of a crack hastily and using only one application of the arc, are common causes for low efficiency and re-opening of these welds, as the heat, suddenly applied, intense and of limited duration, not only lacks sufficient time to distribute itself by radiation, but causes the welded metal to become brittle and lifeless, which fails in resisting the expansion, before subsequent cooling takes place, thereby opening the weld.

Next to be considered is the filling-in material, its size and analysis. Frequently, this is common wrought iron, or so-called welding wire, and it should not be used until its chemical composition is ascertained. Much of this welding iron contains a large amount of slag, and its carbon content is too high, causing weakness and hard spots in the weld. The best and purest Norway iron should be used, ranging in carbon from 0.07 to 0.10 per cent, the diameter depending upon the thickness of the metal to be welded and the depth of the defect. When using wire of small diameter, the flame of the arc practically burns the life out of the material before it enters the defect. When too heavy material is used, particles are burnt off and enter the weld faster than proper fusion can take place. It has been found that for the ordinary range of work, wire from ¼ to 5/16 inch in diameter, is best adapted.

Proper Method of Procedure

Considering that nearly every crack is of different length and depth, the first thought is whether it is wise and practical to repair it with the electric arc, or whether it should be condemned and cast over. Good judgment should be exercised in this respect and due consideration should be given to strength and safety.

A crack to be welded should first be burned or cut out V-shape, to its foundation, care being exercised not to cut away more of the original metal than possible. Burning it out with the arc is not considered good practice, as the sudden and excessive heat leaves a zone of oxidized metal adjacent to the weld, although in many foundries this custom is usually followed, owing to the difference in time and cost, compared with other methods of cutting.

Whenever possible, it is advisable to cut out a crack with a pneumatic tool, after which it should be slowly heated in either an oven or in a forge fire, the extent of heating depending upon the gravity of the defect and sufficient time should be allowed for the maximum expansion.

Small cracks of less importance need little or no preheating, as the temperature of the arc is sufficient.

After properly preheating, the welding should begin immediately. The current supply should range from 250 to 400 amperes, at voltages from 60 to 90, according to the size of the crack. A sharp carbon is highly essential for welding in order to concentrate the flame to a small point. The cable should be as flexible as possible, to permit of the free manipulation of the electrode. The crack should be slightly tilted, so that whatever slag forms will flow to the side of the arc. To eliminate the slag and bring it to the surface, always feed the filling-in material on the dark spot, directly underneath the point of the carbon. The bright or yellow spot is slag.

The material should be fed evenly and without haste. Speed does not produce good results.

A crack should never be welded with one application of the arc, but should be divided into three or four layers, according to its depth, allowing an interval of from two to five minutes between each layer. The first layer should be welded with the maximum amount of current, decreasing the voltage with the last layer, thus reducing the pressure. A reduction in amperes does not reduce the temperature, but reduces the volume. A riser, approximately ¼ inch in diameter, should be left upon finishing the weld, which usually contains the majority of impurities, and aids in retaining the heat.

New Cleveland Stove Foundry for Maximum Output

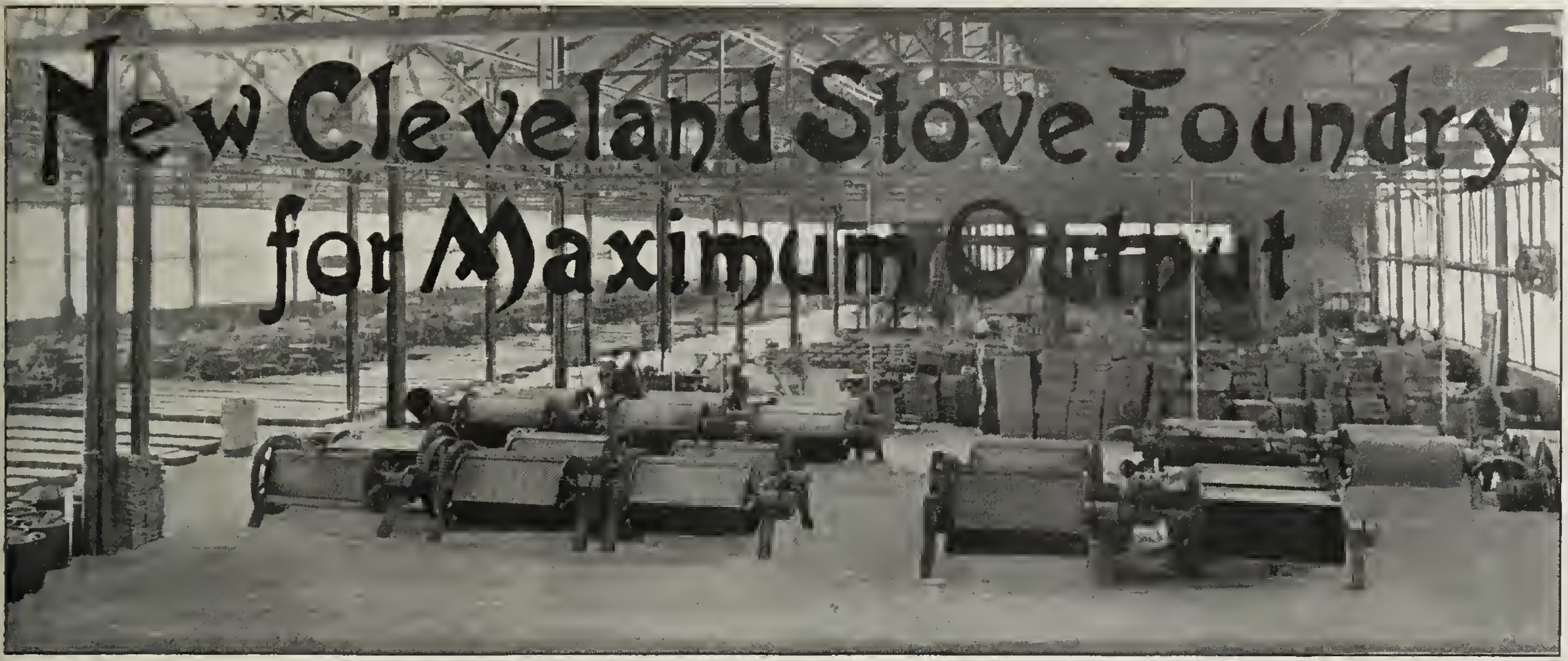


Fig. 1—Looking Toward the South End of the Foundry From the Shipping Office.

UNDER the impetus of the constant flow of orders during the last two years, building construction in the iron and steel industry is advancing with enormous strides. In percentage of new buildings erected, foundries have more than held their own. Maximum production is the goal which every foundryman is seeking and expense is a minor consideration if the output resulting from the expenditure comes up to expectations.

Foundrymen who are familiar with stove foundries know that in the past, scant attention was given to equipment the bare casting essentials being the rule rather than the exception. Now the stove founder is as anxious to attain maximum production as the farmer, the ship builder or the munitions maker. The new plant of the Cleveland Co-Operative Stove Co. is a good example of a plant designed to insure heavy production as well as favorable working conditions for the workmen.

The building was begun in the fall of 1916, the flood of orders for stoves at that time forcing officials of the company to realize how totally inadequate the old shop was to meet them. It was expected that the foundry would be completed late in February, in ample time to store a stock of stoves for the busy season of the present year. Labor conditions and transportation facilities, however, were disappointing; consequently, the work of construction was delayed and the building was not completed until the early part of July. The plant is located on Harvard avenue, opposite the Newburgh works of the American Steel & Wire Co.

The new foundry is 135 x 500 feet, of brick and steel construction. About 400 tons of fabricated steelwork were used. Plans for the building were prepared by Geo. S. Rider & Co., Cleveland, and the building was erected by the National Concrete & Fireproofing Co., of the same city. The steelwork was fabricated by the Penn Bridge Co., Beaver Falls, Pa.

The roof is of the Pond truss type, the lowest point of the monitor being about 2 feet above the level of the side sections of the roof. Three tiers of steel sash, manufactured by the David Lupton Sons Co., Philadelphia, parallel either side of the monitor and a similar number traverse

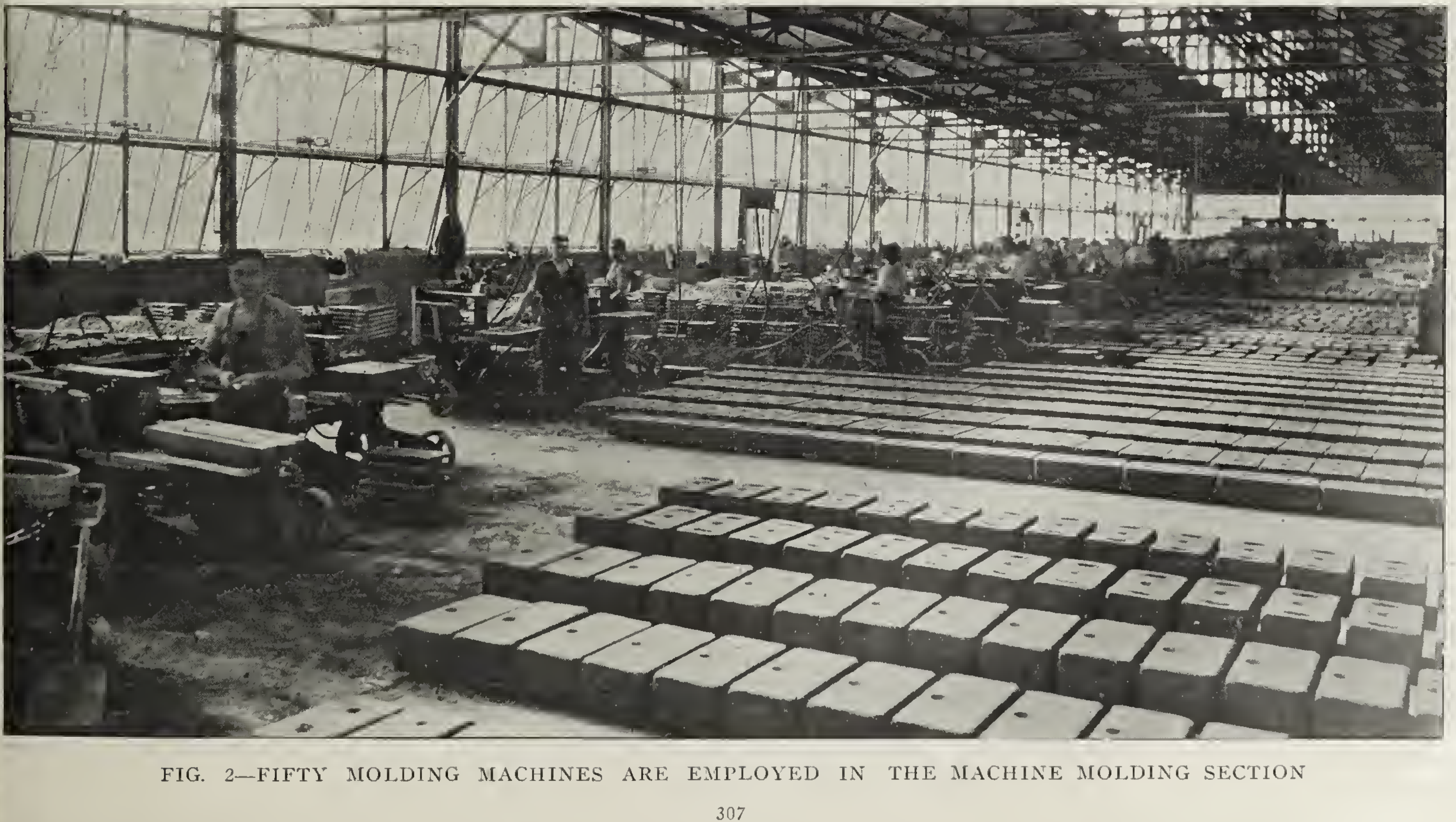


FIG. 2—FIFTY MOLDING MACHINES ARE EMPLOYED IN THE MACHINE MOLDING SECTION

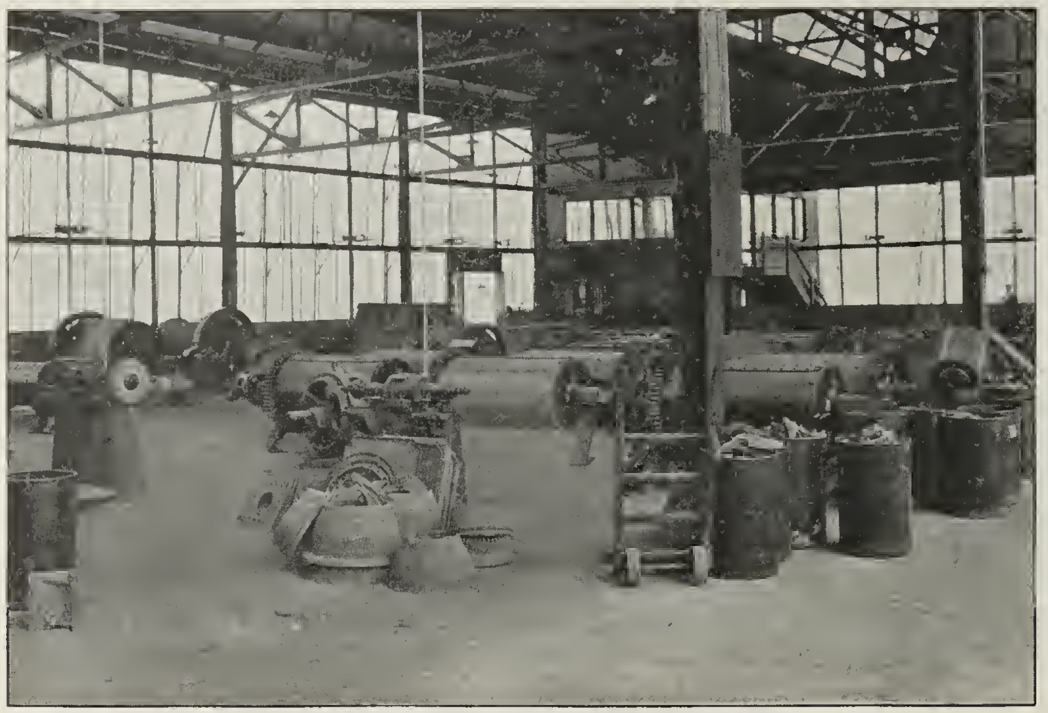


FIG. 3—THE CLEANING ROOM AND THE SHIPPING ROOM OCCUPY THE NORTHWEST CORNER OF THE FOUNDRY

the side walls of the building. Part of the end walls likewise are composed of glass, bringing the total percentage of sash area to about 90 per cent of the total wall area. Splendid light is thus afforded the workmen and the ventilation is such that no ventilators are required to remove the fumes from the molding and cleaning rooms. The problem of artificial illumination also has been solved with equal care. High-power incandescent lamps are suspended in rows of five each, a space of 19.3 feet separating each row. The total number of lamps used is approximately 125. The lights are controlled from a switchboard in the air compressor room.

One of the outstanding features of the foundry, extremely noticeable to an outsider first entering the plant is the fact that not a single crane or hoist of any character is used. The molded stove plates and sections are comparatively light, permitting them to be transferred from one department to another by trucks and wheelbarrows. Electric trucks of the low platform type are employed.

An idea of the general arrangement of the plant may be secured from Fig. 1. The two main bays, each 60 feet wide and 450 feet long, are separated by a 15-foot runway which runs the entire length of the foundry. The east bay is used exclusively for molding, while the west bay accommodates one molding floor and the melting, cleaning and shipping departments. The molding floors occupy between 65 and 70 per cent of the floor area of the entire foundry. Early specifications called for a monorail system to be located in the 15-foot runway, but it was finally decided that the gain from a system of this character would not warrant the expenditure connected with its installation. The greater part of the molding on this floor, consisting mostly of smaller work, is done with molding machines made by the Osborn Mfg. Co., Cleveland. These machines are operated by compressed air, and straddle the heaps of molding sand. This arrangement enables each molder to move his machine along the floor as his day's work progresses. Some hand molding also is done in this bay on work benches, which, like the squeezing machines, straddle the heaps of sand and move on their own wheels. The work done in the hand-molding section is of a slightly heavier nature than that performed on the machines. The heaviest molding is done in the opposite bay in the space between the core room and the cupola. The molding floors are indicated in Fig. 8, which is a plan view of the foundry.

Arrangement of Charging Floor

The melting equipment, shown in Fig. 4, is conveniently situated in the middle of the right-hand bay, equidistant from the extremities of all of the molding floors. The 84-inch cupola, built by the W. W. Sly Mfg. Co., Cleveland. melts about 40 tons of pig iron daily. The charging floor is 35 x 75 feet and is accessible by a stairway in the rear and by an 8000-pound capacity elevator made by the Otis Elevator Co., New York. A 6000-pound capacity scale, made by the Standard Scale & Supply Co., Pittsburgh, is located immediately in front of the elevator. The charging floor is easily capable of holding two carloads of coke and 200 tons of pig iron, which constitute about a week's sup-

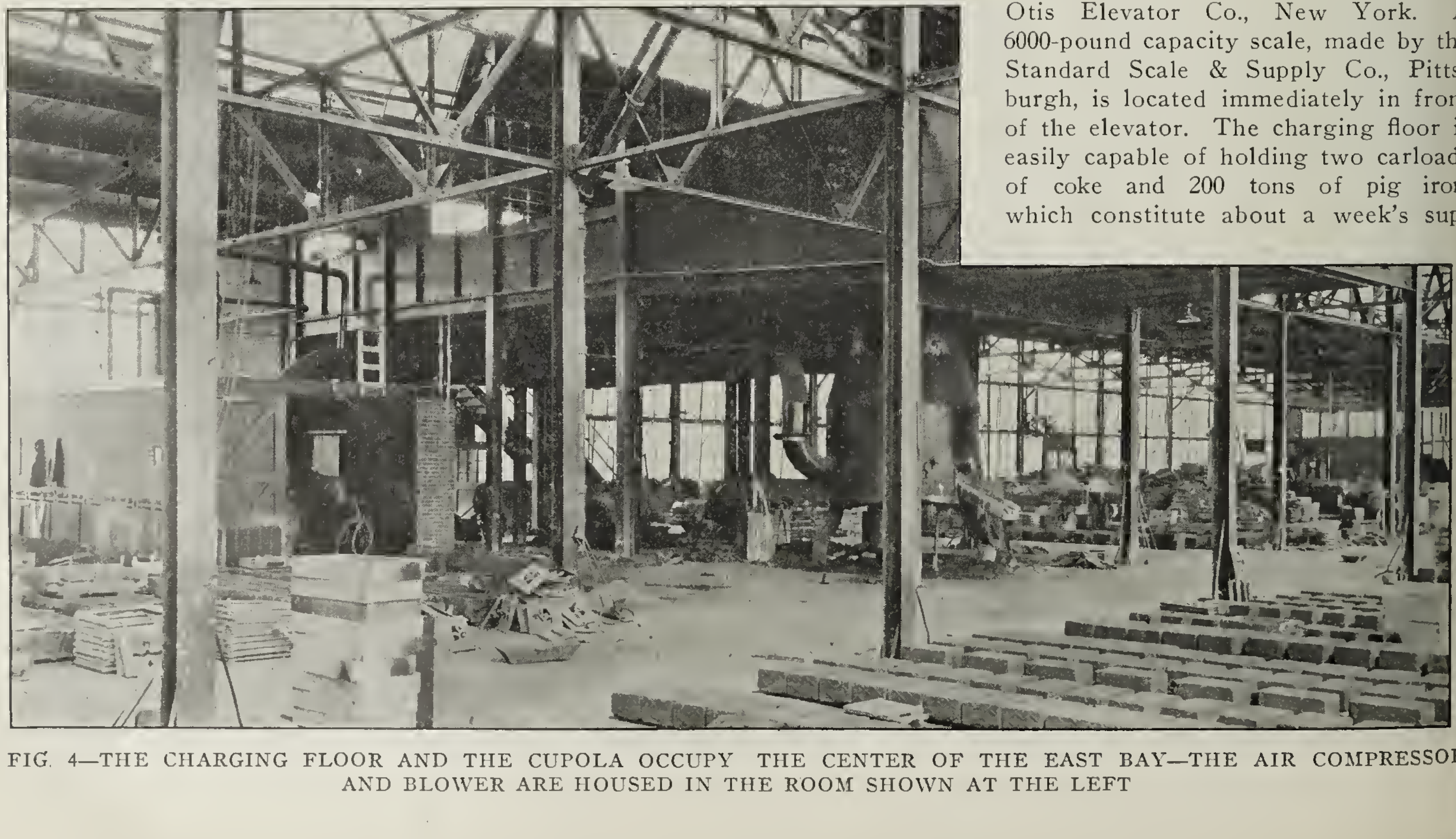


FIG. 4—THE CHARGING FLOOR AND THE CUPOLA OCCUPY THE CENTER OF THE EAST BAY—THE AIR COMPRESSOR AND BLOWER ARE HOUSED IN THE ROOM SHOWN AT THE LEFT

ply. The floor is of reinforced concrete, protected on its upper surface with ⅜-inch steel plates.

Iron is distributed to the molding floors by hand ladles. The iron in the cupola drop is reclaimed by a cinder mill located about 20 feet from the cupola.

The core room occupies an area 50 x 135 feet at the south end of the foundry. As shown in the plan view, this room is divided into two sections by the 15-foot gangway, the section in the west bay tapering from 50 feet in width down to a point. The peculiar construction of the latter room is caused by a corner of the foundry having been cut off in order to accommodate the railroad siding. One core oven of the drawer type serves the requirements of the entire shop. This oven is 18 x 10 x 8 feet and was made by the W. W. Sly Mfg. Co., Cleveland. Cores are made on benches in the core room, and after baking are placed on movable racks and transferred to the molding floors. The oven, shown in Fig. 6, is fired from a pit at one end. Fig. 6 also shows a sand-mixing machine, made by the Sand Mixing Machine Co., New York. This machine is kept in the core room in the day time and prepares the molding sand during the night.

Blower Driven by Alternating Current

The blast for the cupola is furnished by a blower installed by the P. H. & F. M. Roots Co., Connersville, Ind. The blower is driven by a 50-horsepower alternating-current motor made by the Lincoln Electric Co., Cleveland, and provides a blast pressure of 14 ounces. The blower is housed about 40 feet from the cupola on the main floor.

The air compressor which supplies air for the molding machines is located in the room containing the blower and elevator machinery. It is driven by a 50-horsepower alternating-current motor, and provides a pressure averaging approximately 100 pounds.

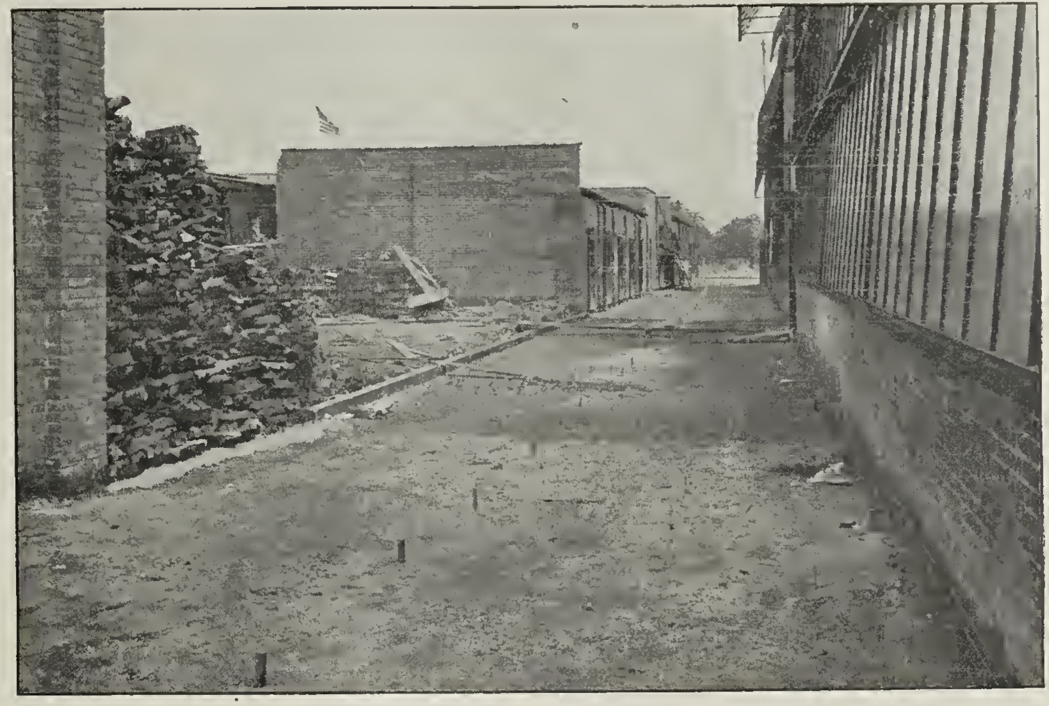


FIG. 5—THE RUNWAY BETWEEN THE STORAGE BUILDINGS AND FOUNDRY PROPER WILL BE PAVED WITH CONCRETE

The cleaning room, located north of the cupola in the east bay, is approximately 60 feet square. The equipment in this room includes 24 tumbling barrels made by the W. W. Sly Mfg. Co., and four double grinders, made by the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn. Like the air compressor and blower, this equipment is operated by alternating current. As shown in Fig. 3, the tumbling barrels are arranged in four groups of six barrels each and the grinders are placed in a line about 10 feet apart, parallel to the barrels. This arrangement facilititates the transfer of castings for the two operations.

The blower system for the cleaning department, installed by the Ohio Blower Co., Cleveland, is claimed to be unique. One 5-inch exhaust pipe is connected with each separate tumbling barrel and one 4½-inch pipe with each double grinder, making 28 pipes in all. The 70-inch fan is operated by an alternating current motor. All of the exhaust pipes converge in a cyclone on the roof where the dust is separated from the air by centrifugal force, the dust falling into a waste pipe from which it is removed in trucks.

The shipping room adjoins the cleaning room and occupies approximately the same amount of floor space. Inasmuch as the company was unable to bring the railroad siding

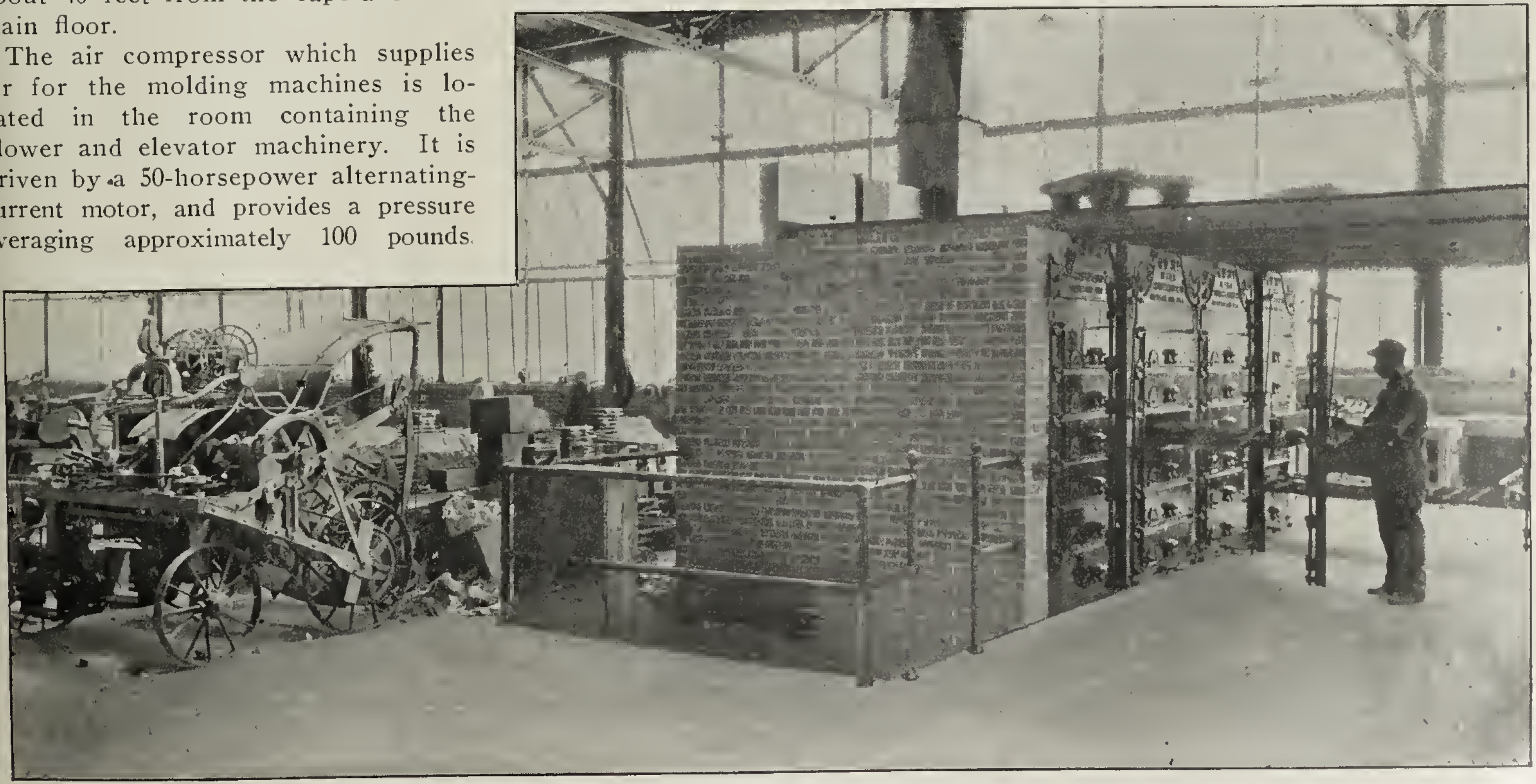


FIG. 6—THE CORE OVEN IS OF THE DRAWER TYPE—THE SAND MIXING MACHINE SHOWN AT THE LEFT PREPARES THE MOLDING SAND DURING THE NIGHT

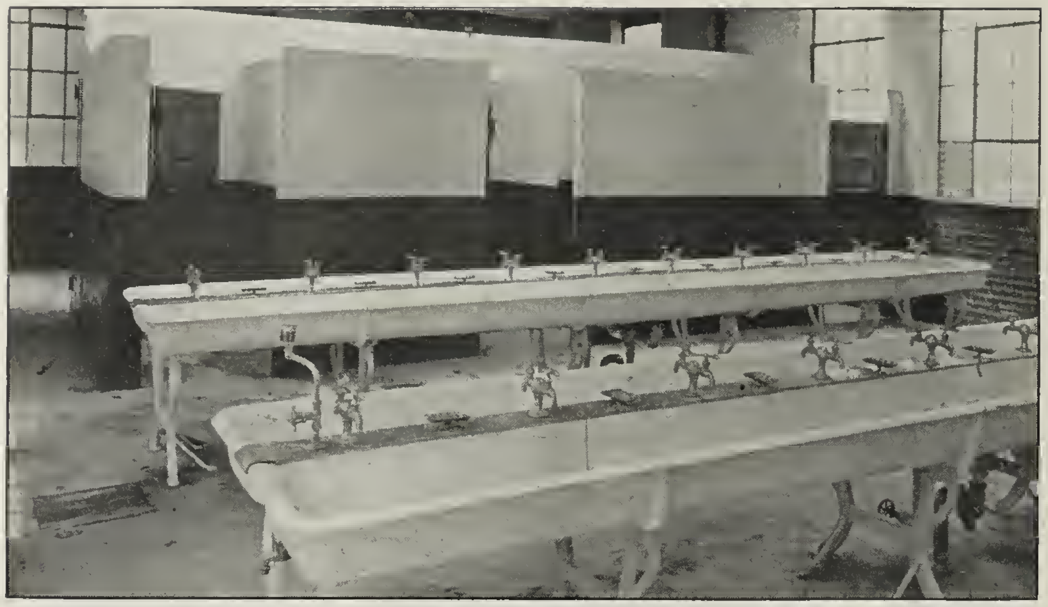


FIG. 7—SHOWER BATHS ARE PROVIDED FOR THE MEN

alongside the shipping room, it was decided to pave the way to the siding, enabling the finished products to be trucked over this expanse in all kinds of weather. This arrangement turned out so satisfactorily that it was decided to pave the yard between the main buildings and all outbuildings. Fig. 5 illustrates this long passageway and shows the first filling of concrete.

Storage Buildings

The sand limestone and clay are stored in reinforced concrete and brick buildings immediately outside the main buildings, as shown in the plan view. Coke and pig iron are stored in the open, opposite the elevator leading to the charging floor. Trucking of all outside material is greatly facilitated by the concrete runway.

The floors of all departments of the foundry are of concrete laid by the National Concrete & Fireproofing Co. A metallic hardening, manufactured by the Master Builders Co., Cleveland, is mixed with the concrete to give it a hard and tough surface, and also to enable it to keep from cracking under contact with molten iron. The 15-foot runway has been especially treated with this substance.

Lockers for the men, are located in the small building on the Harvard avenue side of the foundry. This arrangement enables the men to change clothes before and after working hours. The locker room is partitioned off from the wash and shower bath room, as shown in the plan view. Drinking fountains are placed at convenient points throughout the shop.

The site on which the foundry stands is 250 x 900 feet. The foundry was erected under the direction of J. H. O'Brien, president of the Cleveland Co-Operative Stove Co. Other officers of the company are: J. T. Gill, vice president; W. W. Ludlow, secretary and treasurer. James Mitchell is general superintendent. The old foundry will continue in operation, until further construction planned on the new site is carried out. Scarcely any of the labor in the old plant was transferred to the new plant, almost all of the 250 workmen having been secured from outside sources.

It is a popular theory that nickel will cause lead to remain in solid solution with copper, but as a matter of fact lead is only partly miscible with nickel and copper in the molten state. The temperature of complete solidification of the mixture is identical with the solidification point of lead, and the constituents of such alloys are solid solutions of copper and nickel and nearly pure lead.

Preventing Cupola Bridging

By W. J. Keep

Question.—Our cupola is only 26 inches in diameter and in making heats averaging 3000 to 3500 pounds, it bridges above the tuyeres. We do not slag-off throughout the entire heat. The furnace is provided with six tuyeres located 12 inches from the bottom and we would like to have you advise us whether we should close one-half of these.

Answer.—It requires considerable experience and great care to melt iron satisfactorily in a small cupola. The pig iron and scrap should be broken small and should be charged very evenly and no dirt should be thrown into the stack. Screen out all small iron particles and shot and place them on the sand bottom or on top of the last charge. The tuyeres should be as large as possible, 12 inches being approximately the right height. If you exercise care you should be able to melt the amount of iron mentioned without much difficulty. You can overcome all of your trouble by slagging. No cupola should be run without the slag hole open, especially a furnace of such small diameter.

When cerium is heated in an atmosphere of hydrogen it rapidly absorbs this gas at about 350 degrees Cent. Between 450 degrees and 510 degrees Cent. the dissociation pressure is about 1 millimeter corresponding to CeH_2; beyond this the dissociation pressure increases with the hydrogen concentration. It is probable that when cerium takes up hydrogen that the hydride is first formed and the hydride then dissolves more hydrogen.

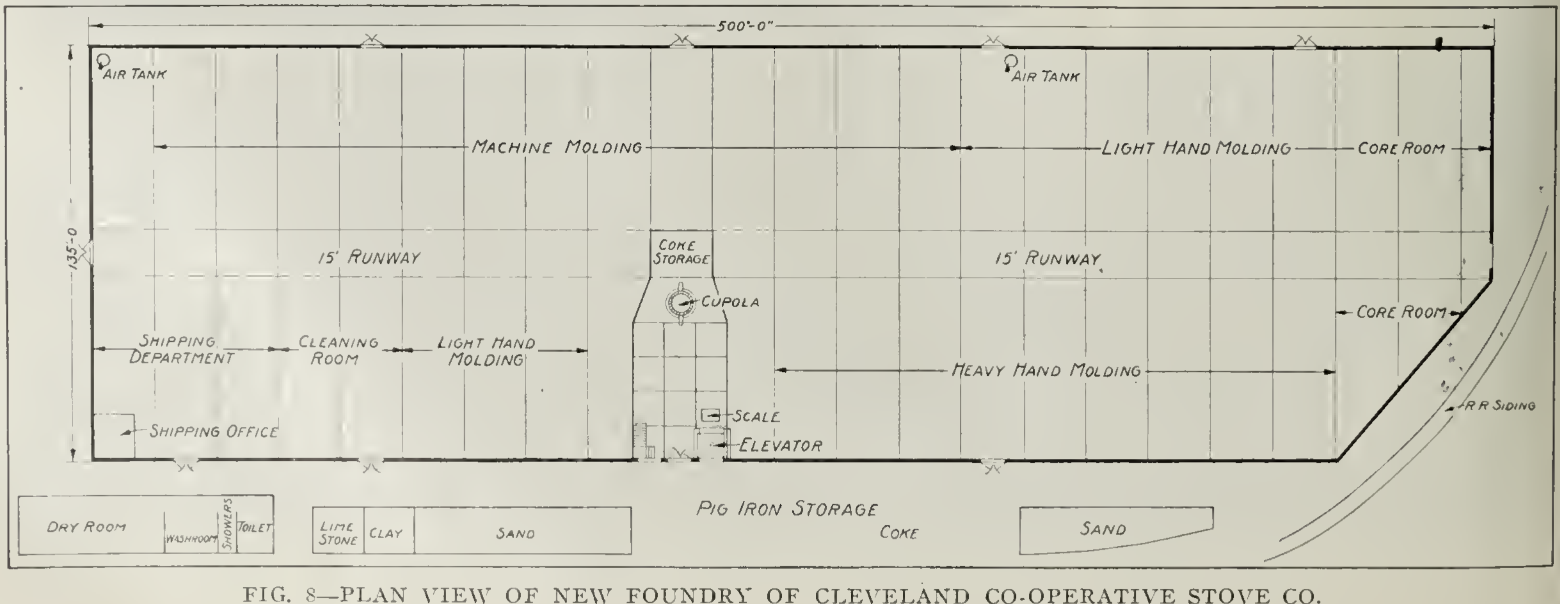


FIG. 8—PLAN VIEW OF NEW FOUNDRY OF CLEVELAND CO-OPERATIVE STOVE CO.

Institute of Metals Prepares a Great Program

Tentative List of Papers Announced Forecasts Interesting Meeting at Boston —Manufacturers' Reservations Insure Success of Foundry Equipment Show

ALTHOUGH the opening date of the great exhibition of foundry equipment and supplies, machine tools and accessories, to be held at Boston, beginning Tuesday, Sept. 25, is nearly two months distant; a total of nearly 40,000 square feet of floor space already has been reserved by 120 manufacturers. This foreshadows the biggest show of its kind ever held in New England and promises to eclipse, both in size and number of exhibitors, any previous undertaking by the American Foundrymen's association.

The general arrangement of Mechanics building, where the exhibition will be held, adapts itself unusually well to the unusual types of displays that will be made. Still exhibits will be located in one section of the building, apart from the operating displays, and all of the heavy machinery will be placed in one part of the hall at a distance from the still exhibits. In view of the uncertainty of railroad facilities during the months of September, and the delays in shipping already experienced, C. E. Hoyt, exhibition manager, has requested manufacturers to ship their equipment as far in advance of the opening date as possible. Storage space has been obtained in Mechanics building of sufficient capacity to take care of all of the equipment that is delivered in August and early in September.

The committees of New England foundrymen are busily engaged in making arrangements for the reception and entertainment of the large number of foundrymen who will attend this big event.

Program of Institute of Metals

W. M. Corse, secretary of the American Institute of Metals has issued the tentative program of the annual meeting of his organization, which will be held concurrently with the convention of the American Foundrymen's association. An imposing array of papers will be presented on various subjects of practical interest to brass foundrymen. Separate sessions will be devoted to the discussion of crucibles and furnaces, the melting and casting of nonferrous metals, casting alloys in connection with the manufacture of munitions, the testing of nonferrous metals and metallography.

The papers which have been selected deal with subjects of unusually timely interest to foundrymen. The tentative program is as follows:

Crucibles and Furnaces:

"The Crucible Situation," by Prof. A. V. Bleininger, Bureau of Standards, Pittsburgh, Pa.

"Melting Yellow Brass in New Form of Induction Furnace," by G. H. Clamer, Ajex Metal Co., Philadelphia, Pa.

"The Crucible Situation," by M. McNaughton, Jos. Dixon Crucible Co., Jersey City, N. J.

"The Electric Furnace and Nonferrous Metals," by Dwight D. Miller, The Society for Electrical Development, New York City.

"My Experience with Metal Melting Furnaces," by W. H. Parry, National Meter Co., Brooklyn, N. Y.

Melting and Casting Nonferrous Metals:

"Casting Bearings in Sand and Metal Molds," by R. R. Clarke, Pittsburgh, Pa.

"The School End of the Job in Training Foundrymen," by C. B. Connelly, Dean, Carnegie Institute of Technology, Pittsburgh, Pa.

"The Flux and Cleaner Question of Brass," by E. D. Frohman, S. Obermayer Co., Pittsburgh, Pa.

"Negative Experiments on Waste Core Sand," bv Dr. H. W. Gillett, Bureau of Mines, Ithaca, N. Y.

"Pyrometers—Their Construction and Application," by John P. Goheen, Brown Instrument Co., Philadelphia, Pa.

"Surface Tension and Deoxidizing of Metals," by W. J. Knox, Metals Deoxidizing & Refining Co., New York City.

"The Briquetting of Nonferrous Light Metal Scrap," by A. L. Stillman, General Briquetting Co., New York City.

"The Swelling of Zinc Base Die Castings," by H. M. Williams, National Cash Register Co., Dayton, O.

Munitions, Etc.:

"The Present Status of Tin Fusible Plug Manufacture and Properties," by Dr. Geo. K. Burgess and Mr. Gurivitch, Bureau of Standards, Washington, D. C.

"Stellite," by Elwood Haynes, Haynes Stellite Co., Kokomo, Ind.

"Fire Prevention in Large Industrial Establishments," by C. W. Johnson, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

"The Use of Die Casting in Munitions," by Charles Pack, Doehler Die Casting Co., Brooklyn, N. Y.

"A Few Points on Alloy Patents," by Wm J. Rich, Government Patent Office, Washington, D. C.

"Shrapnel Bullets," by Harold J. Roast, the James Robertson Co., Ltd., Montreal, Can.

"Recent Industrial Uses of Aluminum," by F. G. Shull, Aluminum Co. of America, Boston, Mass.

Testing Nonferrous Metals:

"Some Comparative Tests on Test Bars and Actual Castings," by W. M. Course, the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., Buffalo, N. Y.

"Analysis of Babbitts and Brasses," by E. W. Hagmaier, Buffalo, N. Y.

"Standard Test Bars of 88-10-2 and 88-8-4, being the result of co-operative work of six foundries; a new series of tests," by C. P. Karr, Bureau of Standards, Washington, D. C.

"The Expansion Co-efficients of Alpha and Beta Brass" and "The Corrosion of Manganese Bronze Under Stress," by Dr. Paul D. Merica, Bureau of Standards, Washington, D. C.

"Corrosion of Brasses of the Muntz Metal Type," by H. S. Rowdon, Bureau of Standards, Washington, D. C.

"Analysis of Cadmium in Brass," by Dr. F. Schramm, Bureau of Standards, Washington, D. C.

Metallurgy and Metallography:

"The Electrolytic Production of Antimony," by Prof. D. J. Demorest, The Ohio State University, Columbus, O.

"The Electrical Properties of Some High Resistance Alloys," by Prof. M. A. Hunter, Rensselaer Polytechnic Institute, Troy, N. Y., and F. M. Sebast.

"The Amorphous Theory in Metals," by Prof. Zay Jeffries, Case School of Applied Science, Cleveland, O.

"The Uses and Metallurgy of Antimony," by K. C. Li, Wah Chang Mining & Smelting Co., Inc., New York.

"Development and Reabsorption of the Beta Constituent in Alloys which are normally of the Alpha Type," by Prof. C. H. Mathewson, department of mining and metallurgy, Yale university, New Haven, Conn., and Philip Davidson.

Analysis of Alloy Corrected

On page 273 of the July issue of THE FOUNDRY a table was published containing the following caption: "Physical Properties of the Alloy: Copper 80 Per Cent; Tin, 10 Per Cent; Zinc, 10 Per Cent." This alloy should have been: Copper, 80 per cent; tin, 10 per cent, and lead, 10 per cent, as with 10 per cent of zinc, the alloy would have been glass-hard.

The American Foundry Equipment Co., New York, recently issued an attractive sand-blast catalog which illustrates and describes the complete line of machines built by this company.

The Kirk Supply Co., Pittsburgh, recently has received a number of contracts from foundries and iron and steel works, including the following: Twenty-five charging box cars, to be built by the Easton Car & Construction Co., Easton, Pa., for delivery to the Canton Sheet Steel Co., Canton, O.; six cars of similar type for the Edgewater Steel Co., Pittsburgh, with works at Oakmont, Pa.; complete foundry flask requirements, to be furnished by the Sterling Wheelbarrow Co., Milwaukee, Wis., for the Producers Supply Co., Franklin, Pa.; three ¾-yard concrete mixers of the Marsh-Capron type and 1000 Sterling column clamps for the Union Switch & Signal Co., which is building a new plant at Swissvale, Pa.

A Study of the Steel Foundry Sand Problem

Molding Sand for Steel Castings Must Be Plastic, Non-Yielding, Permeable to Gases, and Capable of Resisting High Temperatures

By G Muntz and E Roubien

THAT the problem of sand, for the steel foundry, has been considered a very important one for a long time is indicated by the tremendous amount of literature available on the subject. The American Foundrymen's Association undertook an exhaustive study of foundry sands in general, but the scope of the problem was so large that it had, finally, to enroll the help of the bureau of standards, at Washington, D. C. The bureau is crowded with work. It can devote but a fraction of its time to the question, so it ensues that such conclusions as it will reach will necessarily be belated. The Tropenas Converter Co., in putting its process in operation in steel foundries, was confronted with this sand problem several years ago, and worked out a solution satisfactory to its engineers.

The data gathered at the time were boiled down, and a set of instructions were adopted. These instructions included reasons for the solution reached and the problem was reviewed from all angles. In the belief that the data would be of interest to the foundry industry they are being published today for the first time.

Physical Composition of Sand

It is well to remark, at the beginning, that in the steel foundry, we are in the presence of the highest temperatures at which ferrous metals are cast. We have, therefore, to deal with the most arduous problem involving refractoriness of molds.

The qualifications of sand suitable for molding are the following:

Molding sand, it is pointed out by Dr. Moldenke, must be plastic, non-yielding, permeable to gases, capable of resisting high temperatures readily, and after serving its purpose, must be easily destroyed. Furthermore, if any material answers all these conditions, its cost will have to be considered, in order to ascertain whether the advantages expected from its use are not secured at prohibitive expense.

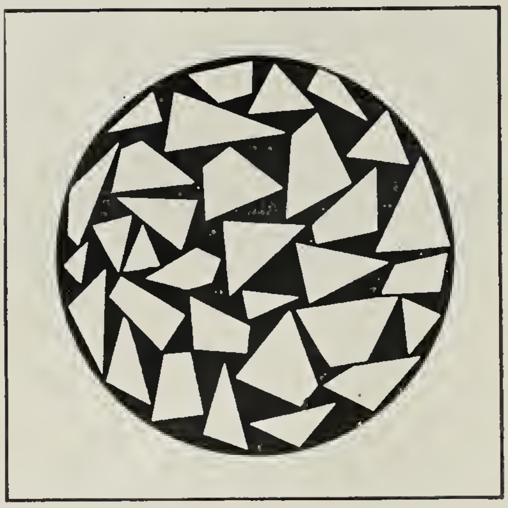


FIG. 1—SHARP SAND RAMMED IN A MOLD, SHOWING LARGE VOIDS

Molding materials are used throughout the country; they should, on this account, consist of minerals very widely distributed in nature, thus explaining why sand has been, from time immemorial, used for the purpose. It consists chiefly of silica, which, next to oxygen, is the most abundant element in existence. It has a very high melting point and is found in small particles which will readily espouse and reproduce the shapes to be molded. This granular texture will also provide such voids as will permit of easy evacuation of the gases and steam evolved in the molds while pouring. But the various particles of silica do not adhere to each other naturally, thus an agglomerating medium will have to be called upon, if the good qualities of silica are to be taken advantage of.

Clays have been chosen to agglomerate silica because they are themselves refractory and can be found most anywhere; some have no plasticity and are, therefore, of no value to cement the silica particles, while others, for some reasons yet unknown, will form with pure silica, a plastic compound which is most suitable as a molding medium.

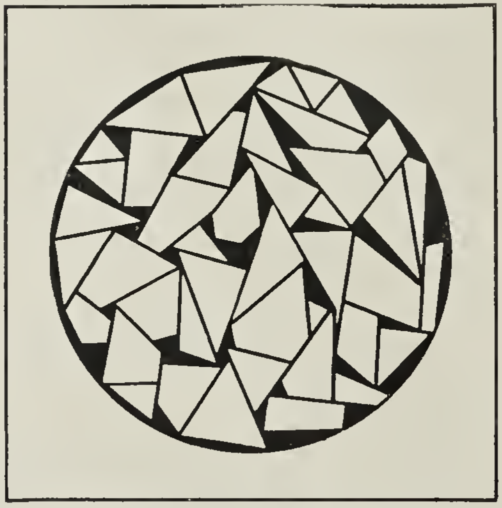


FIG. 2—THE SAME SAND RAMMED IN A DIFFERENT MANNER WITH LESS VOIDS

There are other refractory materials possessing a much higher melting point than silica, but on various accounts are not used for molding. Thus, certain clays such as the kaolins, fuse at temperatures above those usually encountered in the steel foundry, but molds made of these would have to be dried thoroughly in order to be non-yielding and in drying would shrink to such an extent, and so irregularly, that it would be almost impossible to preserve trueness to pattern. Besides, permeability to gases would be almost nil, and the destruction of the molds, after serving their purposes, would be most difficult.

Either magnesia, lime or alumina are more refractory than silica, but not as widely distributed, and all lack some of the qualities indispensable to molding media.

It seems then that sand, consisting of silica, clay, and their inherent impurities, is the only material we can use for molding purposes. We will, therefore, continue our study on that basis.

Chemical Composition of Sand

Silica is found, in the natural state, generally as quartz, which is almost pure SiO_2. Silica melts at about 1,600 degrees Cent. (2,900 degrees Fahr.); it contains as impurities affecting its melting point, alkalies, basic fluxes and metallic oxides. But these are present in very small quantities and have practically no effect on the whole, so we can safely say that ordinary pure silica sand does not melt at the temperatures encountered in steel molds.

However, silica cannot be used alone, and as we have already seen, admixtures of clay must be made to agglomerate the mass. It thus behooves to ascertain what effect heat has on clay. To those who want detailed information on the subject, we would recommend "Technologic Paper No. 7, The Testing of Clay Refractories," issued by the bureau of standards, Washington, D. C. For the purpose on hand, the following resume will answer.

"The principal ingredient of fire clays is a hydrous silicate of alumina, or kaolinite, of the formula Al_2O_3, $2SiO_2$, $2H_2O$ corresponding to the following

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From the February, 1917, issue of *Steel Castings*, published and copyrighted by the Tropenas Converter Co., New York. The authors, G. Muntz and E. Roubien, are with the Tropenas company.

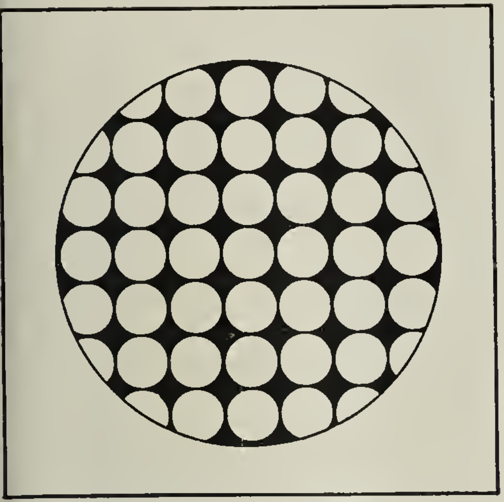

FIG. 3—ROUND SAND RAMMED IN A MOLD SHOWING CONSTANT VOIDS

percentage of silica, aluminum and water:

	Per cent.
Silica, SiO_2	46.3
Alumina, Al_2O_3	39.8
Combined water	13.9

While this substance, commonly called kaolin, does not correspond to the most refractory mineral combination of silica and alumina found in nature, it is at least, the most commonly distributed material, since it may be assumed to be the fundamental constituent of all fire clays." It melts at about 3,200 degrees Fahr.

Composition of Clays

Clays, however, are seldom found pure, and contain quite considerable proportions of alkalies, lime, magnesia, ferric oxides, and free silica. Let us see what action these different impurities have on clays under the influence of heat.

Alkalies—These have a relatively low melting point (2,550 degrees Fahr.). They are so called neutral fluxes, as they do not unite with pulverulent silica, but dissolve it, thereby reducing the general refractoriness of clays to a large degree.

Lime—This element, united with silica, forms very fusible silicates which deform and flow at the temperature of liquid steel.

Magnesia—Magnesia acts very much like lime, but not in as marked a degree. It lowers the melting point of the silicates already formed, but not as strongly as ferrous oxide.

Iron Oxide—This impurity being present in a finely divided condition, acts as a very potent flux, and is most injurious to fire clays at high temperatures.

What really happens is a dissociation of the higher oxides into the lower form FeO which, at the temperature involved, combines with silica to form ferrous silicate. This silicate is highly fusible and results in a strongly corrosive slag which attacks clay most vigorously.

Silica—Free silica in clay acts as an impurity, as it serves to lower the melting temperature. We will see later that for molding purposes, clays are ground very fine, so that the silica they contain, will itself be present in extremely fine particles, these are dissolved by the alkalies, as seen above, and when liquid, act in turn as solvents of alumina, thereby lowering the melting point of the clay.

The foregoing can further be condensed as follows:

Steel molding sand is a compound of silica and clay.

Silica expands when heated, counteracting clay which contracts.

Clay is a fine grained mixture of kaolinite and impurities consisting of free silica, iron oxides, lime, magnesia, and such alkalies as are carried by natural feldspars.

Weber shows that when a clay is heated gradually to complete fusion, at first fritting occurs, then the neutral fluxes fuse and the liquid part gradually dissolves the adjoining particles, first siliceous, then aluminous, the fine particles more readily than the coarse until finally the whole has been liquefied to a homogeneous solution.

In the steel foundry, clay is, therefore, the necessary evil, as it is the carrier of the fluxes which attacks the almost pure silica of sand.

If we now compare these requirements to those expected of sand, we find that our problem is almost solved because silica mixed with very little clay is:

1—Plastic on account of the mobility of its particles and the plasticity of the bond.

2—Almost infusible at molten steel temperature.

3—Most unyielding, inasmuch as the quartz forming its foundation is one of the hardest minerals known.

4—Will be easily broken up after serving its purpose, as clay will not be present in sufficient quantities to give the mass of brick-like structure, and easy fritting will ensue after exposure to heat.

5—Very economical on account of the wide distribution of the components, their easy availability and their ensuing low cost.

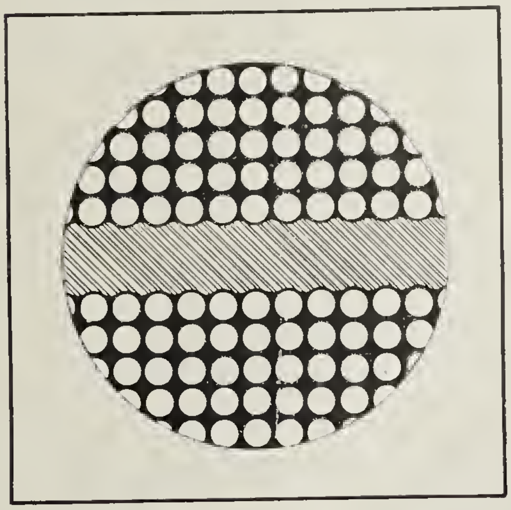

FIG. 4—EFFECT OF QUICK CHILLING

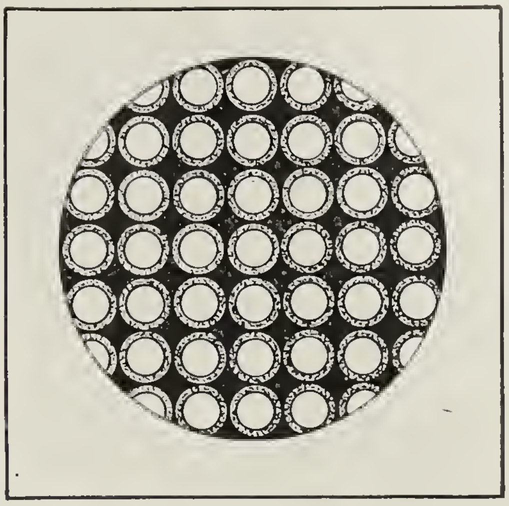

FIG. 5—DIAGRAM OF IDEAL FOUNDRY SAND

The point in doubt covers, therefore, permeability to gases and steam.

The open spaces which exist between the various particles of sand, measure the extent of permeability to gases and steam. Let us suppose that the particles are angular, namely, composed of flat surfaces meeting in the shape of sharp angles. In ramming up a mold, we have no control whatsoever over the orientation which the various particles will assume, so that sand, in a mold, will appear in cross section, either as shown on Fig. 1 or as illustrated by Fig. 2. In the first case, we have greater permeability than in the second, although dealing with exactly the same material.

If we now consider spherical particles as shown on Fig. 3, we will note at once, that no matter how we ram our sand, and disturb its elements, the voids left between them will remain the same, resulting in the preservation of such constant degree of permeability as is deemed satisfactory.

Sands as provided by nature, are usually round grained, and, if they meet the chemical requirements, they represent the class used in the steel foundry.

Influence of Grain Shape and Size on Refractories

It is a plain matter of common sense to state that a small piece of sugar will dissolve faster, in a glass of water, than a larger piece. The same applies to silica taken up in solution by impurities melting at a lower temperature. Thus, crushed silica will see its sharp edges molten very rapidly, while round grained silica will present an almost solid front to melting influence. This is another argument in favor of the latter sand.

On the other hand, a very small round grain of silica will be easily taken up in solution, while too coarse a one will produce rugose walls in the molds, and, therefore, rough castings.

Fineness means also, decreased permeability to gases, so that sand will have to be graded, as to grain, by the foundryman to meet his particular requirements in this respect.

If small castings of thin section are to be produced, the metal when coming in contact with the sand will chill rapidly and will not readily attack the walls of the mold. On the other hand, and on account of the same fear of rapid chilling of the metal, gases must be quickly evacuated; thus a fairly large grain, insuring great permeability, seems indicated. In Fig. 4 we have purposely exaggerated the size of the sand grains in order to show how quick chilling of the metal prevents it from entering every little wall cavity, thereby ensuring smooth castings with relatively coarse sand.

When making castings of heavier section, the bodies of metal remain liquid longer and are more apt to seriously impair the walls of the molds. Very smooth and continuous mold surfaces are, therefore, required, meaning a smaller grain with its decreased permeability. In this case, however, gases have plenty of time to escape before the metal solidifies, and fineness is not at all objectionable on that score, but greatly beneficial in obtaining smooth castings.

In the case of large castings of heavy section, the facing sand should still be finer, but owing to the length of time the metal will then remain liquid, and the ensuing larger quantities of gases and steam to be evacuated, it will be well to either back the facing with coarser sand or else vent the mold profusely. Thus we come to the conclusion, quite at variance with usual practice, that sand must be relatively coarser to produce small castings than to turn out large ones.

Natural Sands

The first question coming to mind is that, as nature is usually a good provider, there might be some sands which in the original state, are suitable for steel molding. Nature made two great divisions. The first covers sands consisting mostly of pure silica, having, therefore, no bonding power without suitable admixtures of clay; the second offers sands which are already composed of silica and clay. We find the latter materials in the trade under the name of strong silica sand, while the former are called sharp silica sand. (Why sharp, we do not know.)

Nature, however, intended sands for a multitude of other uses than the steel foundry. It is then not surprising that the strong silica sands available differ very widely in composition with the localities in which they are found, and that extensive variations occur even in the different parts of the same quarry.

The only conclusion to be drawn, is that on account of uncertainty as to the proportion of the components, the steel foundryman using strong sand, is always in the dark as far as clay contents are concerned. The average analysis might be satisfactory, but fluctuations are so wide, even in one carload, that strong silica sands do not seem advisable for steel foundry use.

The Ideal Steel Foundry Sand

For permeability's sake, silica should present itself in particles as spherical as possible and these, having no cohesive attraction for each other, must be mixed with clay bond. It behooves us, therefore, to determine in what shape this clay bond should be introduced in our ideal sand.

In ramming the sand in molds, the particles are disturbed from the position they occupied when first thrown in; any given one must then be self supporting and be able to adhere to any and all of its neighbors and therefore must be thoroughly covered with the bonding material.

Clay is the enemy, it fuses at high temperatures, on account of the impurities it carries, and because of its very fine texture. The coating of clay that each particle of silica is to receive should then be reduced to a minimum.

Ideal foundry sand is shown schematically in Fig. 5 and is defined as an agglomeration of spherical particles of silica, each covered with as thin a coating of clay as can be applied on them.

To cover each particle of silica with as thin a coating of clay as possible, two conditions must be fulfilled, namely, the silica must be rolled in clay through adequate means, and the clay must be susceptible of assuming the nature of a thin coating.

The first condition is easily met, as we shall see later, but the second is very difficult to fulfill in practice. Clay is one of the most difficult materials to grind; not that it is hard, but being plastic, the least humidity will cause it to lump, and if clay in any amount is localized in sand, contact with hot metal will melt it, and the result will be lumps and burned in sand on the castings.

To achieve extreme fineness, clay must be ground absolutely dry, and then driven through an air separator, which accepts the very fine material and rejects the lumps and grits.

This operation is called air floating. It consists merely in grinding the clay and dropping it in a chamber from which the air is drawn by a strong exhauster. The light material is carried off by the air while the heavier falls by gravity and is returned to the grinders. Water floating achieves better results, but is slow and wasteful.

Air floated clay will average from 95 to 98 per cent fineness through a No. 200 sieve, and it is useless to state that if properly handled, this material will be ideal for use, in connection with such silica sands as are almost devoid of bond.

Covering the particles of silica with as thin a coating of clay as possible can only be accomplished by rolling them in the clay. None but spherical, cylindrical or conical objects will roll, but only the spherical ones will become entirely covered, as the other two have always more than one point in contact with the bond, and the ends will never become coated regularly.

Round grained, sharp silica sand mixed with thoroughly air floated clay will, therefore, give ideal steel foundry sand. To mix these two constituents according to the rules already laid down, mechanical means must be devised. Complicated machinery meant for this purpose, can be found on the scrap heap of many a steel foundry. The old pan grinder seems yet the most efficient, although many of its users do not quite understand why.

Let us consider a grinder in which the pan is driven and the rollers revolve on account of the pan's tractive effort. As soon as motion obtains, we can see that on account of difference in speeds, between points on the pan and corresponding points on the rollers, a slippage will occur between them, causing the particles of materials in between, to be rubbed together, thus achieving the ends in view. This same rubbing effect can be obtained with a stationary pan and driven rollers, but in this case the slippage is not as appreciable unless the rollers are made very wide of face. To increase slippage, some rollers are grooved with resulting quicker operation.

Sand Specifications

Our experiments on this subject are not complete but general data are already available as follows:

It is evident that ideal conditions would be obtained if the spherical particles of silica were of equal size. Silica sands, however, cannot be obtained of uniform grain, they should then be specified as round grained and as passing entirely through a maximum mesh, to be selected to suit the work on hand, while only a certain percentage will be allowed to pass through a minimum mesh. This condition insures adequate porosity to gases, as it eliminates the small material which clogs the spaces left between the larger particles.

In a chemical way, silica sand will be specified as containing no less than 98 per cent silica so that little room will be left for impurities.

The clay must be specified by chemical analysis to come as near as possible to the ideal composition of kaolinite, namely, silica from 35 to 50 per cent, alumina from 30 to 40 per cent, alkalies, lime, magnesia, iron oxides to total less than 5 per cent, the remainder to be combined water. Physically, clay will be specified as plastic and passing not less than 95 per cent through a 200 mesh.

It is necessary to point out here, that two sands of identical chemical and physical composition will not always give the same results. This is due to the fact that clays vary in plasticity and bonding power, although showing almost identical chemical analysis. There are no reliable methods to measure this factor, although the dye absorption test advocated by the American Foundrymen's Association might give valuable indications. This is based on the fact that fat clays absorb more dye than lean ones, and is described as follows:

"Use 0.75 gram of anilin green (malachite) dissolved in 250 cubic centimeters of water, shaking five minutes. Add 25 grams of the clay and shake in machine for 10 minutes, then pouring in a settling bottle. Let stand over night. Compare with standard solution of 0.75 grams dye in 250 cubic centimeters of water, shaken and let stand in the same way."

Reclaiming Old Sand

Under repeated reheating to high temperatures, the quartz in sand undergoes two changes. *First,* a number of particles are broken up resulting in easily fused sharp edges, and also in a smaller grain; *second,* such particles as are not broken up increase very rapidly in volume, to the extent of 20 per cent after a short time. This is due to the change from quartz to tridymite as shown by various authorities. Grum-Grzimailo shows that quartz heated to 1,000 degrees Cent. for some time, changes to tridymite with an increase in volume of 14.2 per cent (corresponding to a decrease in specific gravity from 2.65 to 2.32).

On the other hand, clay through fluxing by its impurities, and also on account of exposure to high temperature, loses plasticity, as it is then made to carry more and more inert matter. This explains why in foundries using constant percentages of old sand in their facing mixtures, the appearance of the castings deteriorates quite rapidly. This deterioration is, however, slow enough not to be observed at once by those actually producing the castings, and it often requires a disinterested outsider to point out slow degeneration of quality on this score.

If old sand is used, without any treatment, trouble is bound to ensue, and common sense indicates that by preaching due economy to the molders, thereby reducing the consumption of facing sand to a minimum, nothing but new sand should be used.

To reclaim the live materials from old sand, seems to us an even more wasteful process than throwing the old sand away. The various particles of sand cannot be separated wet. If old sand must be used, it should, therefore be dried, ground and screened to both a minimum and maximum mesh, before going back into new facing. But even after all these costly manipulations, the chemical contents would still be doubtful. Therefore, we ask, is the gain worth the trouble?

Use of Silica Wash

When dry sand molds are found necessary, the prevailing practice is to coat the surfaces, which will come in contact with molten metal, with a wash made up of finely pulverized silica tempered with molasses water.

Such a wash will prove satisfactory, provided the sand on which it is applied is properly compounded, and offers suitable permeability to gases and steam. If the wash is applied on sand which does not answer these requirements, gases and steam will endeavor to escape into the mold, thereby breaking up the coating of silica wash and causing it to flake. This means that the main requirements of the sand are in no wise lessened by the use of silica wash, and that this practice, which possibly results in slightly smoother castings, requires just as severe compounding of the sand.

From our previous remarks it will be seen, however, that almost as smooth castings can be obtained with no wash at all, and with the further advantage of greater trueness to pattern, as any wash will have a tendency to round off corners when applied. The only advantage we can see to a wash, is that in drying, it will cause a hard skin to form on the molds, thereby preventing fritting and washing away of sand particles when the metal is poured in. Our practice has shown that molasses water sprayed over molds made of suitable sand, will achieve this purpose very satisfactorily and economically, insuring also greater trueness to pattern.

Use of Lean Clays as Bond

Mixing of silica sand and clay, is an operation involving the cheapest kind of labor. The exercise of great intelligence and attention cannot, therefore, be expected from such quarters, with the result that the proportions of the various elements, to be mixed, are not always kept as they should.

A small box or measure, is usually provided the man entrusted with this operation, and he is instructed to put so many boxes of clay to each wheelbarrow of sand. What if he puts one more or one less box of clay to the wheelbarrow of sand?

To reduce this human factor to a minimum, we strongly advocate the use of lean clays. This means lesser permeability to the sand, and lesser refractoriness, on account of the presence of larger amounts of impurities and pulverulent materials, but it prevents the vexatious variations of quality, which often cause the producer to look for trouble where none originated.

This study of the sand problem in the steel foundry is not presented as a cure to all molding troubles. The best sand, if not properly armored with nails, where the washing action of molten metal is most intense, will frit, causing scales on the one hand, and sand spots wherever the fritted material will be carried to portions where it cannot escape.

Extensive areas, such as copes overhanging large bodies of metal, will often cave in if not properly armored. In other words, our study does not eliminate the exercise of ordinary care in the use of an otherwise perfect molding material. We have only provided the foundation from which the foundryman must build, but we have not done away with the necessity of his using good judgment and common sense.

Chilling Mine Car Wheels

By W. J. Keep

Question.—Kindly let us have a good mixture for mine car wheels. The treads of the wheels should have a deep chill. We have experienced considerable difficulty in obtaining the required amount of chill. Any advice that you can give us on this subject will be appreciated.

Answer.—In a paper presented before the American Foundrymen's Association several years ago, by J. J. Porter, the following analysis of mine car wheels was given as the average of American practice: Silicon, 0.64 per cent; sulphur, 0.09 per cent; phosphorus, 0.38 per cent, and manganese, 0.44 per cent. The following analysis is suggested: Silicon, 0.60 to 0.70 per cent; sulphur, 0.08 to 0.10 per cent; phosphorus, 0.30 to 0.40 per cent; manganese, 0.50 to 0.60 per cent; combined carbon, 0.60 to 0.80 per cent and total carbon, 3.50 to 3.70 per cent.

A mixture made of this analysis will give you a satisfactory chilling iron. It will be noted that the high sulphur content is expected to impart much of the chill in the presence of the low silicon content. The carbon is rather high, since it is this element on which the sulphur acts. While modern practice depends upon chemical analysis to give the correct mixture, yet in purchasing iron it should be borne in mind that some irons take a natural chill independent of the analysis. Two pig irons having the same analysis frequently will have decidedly different chilling properties.

The Safe Handling of Crucibles in the Foundry

Experience Has Proved That Consistent Practice Assists in Prolonging the Life of Crucibles and Promotes Safety of the Workmen

THE importance of exercising special care when handling crucibles, not only to avoid accidents but also to insure greater length of service, has been greatly underestimated in the past; but in our larger plants foundrymen are now giving considerable attention to the systematic instruction of their furnacemen, melters, and helpers, with a view to keeping the number of accidents as low as possible, and obtaining the greatest number of heats from the pots.

The clay crucibles of former days have been extensively supplanted by better ones made largely of graphite which is capable of resisting exceedingly high temperatures. In fact, crucibles composed wholly of clay have practically gone out of use for the melting of steel and brass, because they can often be used for only one or two heats, and they are more likely to break or crack unexpectedly, thereby causing the workmen to be seriously burned. Moreover, the temperatures that occur in metal-working plants at the present time are higher than those that prevailed when the all-clay crucible was the standard type. The crucible that is now in general use consists mainly of the substance that is variously known as graphite plumbago or black-lead, and which is a practically incombustible form of carbon. This is combined with a small amount of clay, preferably of a special German variety, as a binding material, and perhaps a little fire sand to give the mixture an open grain, so that it can better withstand sudden changes of temperature. Some makers use, in addition, a certain quantity of material obtained by grinding old, worn-out crucibles; but this practice cannot be recommended.

Efficiency of Graphite Crucible

The graphite crucible is doubtless the most efficient yet devised, when cost and all other elements are considered, but it is, nevertheless, somewhat fragile, in view of the fact that it is expected to withstand a heat sufficient to melt refractory metals, and to support, at the same time, very considerable pressure due to the weight of its heavy fluid contents. It is exceedingly important, therefore, to see that all employes fully understand how to handle crucibles in order to reduce the danger of breakage to a minimum; and a great deal can be accomplished in this direction, because graphite crucibles, when properly made and carefully used, can be kept in a fairly safe condition.

The number of accidents from breakage is greater in small plants than in large ones, in proportion to the number of crucibles in use. This is due partly to the greater care that the crucibles receive in the large plants, and partly to the fact that large foundries buy supplies of crucibles considerably in excess of their immediate requirements, storing the surplus ones and allowing them to age or *season*. It is an old saying that crucibles improve as they grow older, and as experience shows that this belief has some actual basis in fact, the date of manufacture should be stamped upon every crucible to assist the annealing men in selecting the oldest and best seasoned of them when additional ones are required for use.

Careful Handling

Good crucibles are expensive, and every foundryman, therefore, desires to obtain the maximum service from them. The foundryman who attempts to increase the useful life of his crucibles by careful handling and by the adoption of approved methods of every other kind, is at the same time promoting safety by preventing accidents from premature breakage. Foundrymen, melters, pourers and helpers, usually expect a crucible to run a certain definite number of heats, and they are likely to be somewhat careless when a new crucible is put in service. For this reason it is wise to assign a number to each crucible, for recording the number of heats taken. The record may conveniently be kept upon a black-board, opposite the appropriate crucible number and in plain view. Everybody then knows just how many heats each crucible has run, and this knowledge often arouses a spirit of competition, which tends to make the men more careful in handling the crucibles, and to increase the service that can safely be had from them.

When crucibles are first received, it is important that they be critically examined for cracks and flaws, not only by the eye but also by tapping them with a light hammer; and all imperfect ones should be rejected. If there is evidence that any of the crucibles in a given shipment have become wet while in transit to the foundry, they should be stored for at least four or five weeks, before being used, in a place where they will dry out thoroughly, even though they may be apparently dry at the time they are received.

When a new supply of crucibles has been carefully inspected and found to be free from defects, the entire lot should be stored for a considerable time in a warm, dry place, and provision should be made to protect them as thoroughly as possible from contact with moisture or with moist air. The roof of a continuously operating core oven is an excellent place for the storage chamber.

The proper annealing of crucibles is of far more importance than is generally realized. It is said that crucibles, when they come from the manufacturer's kilns, contain less than 0.25 per cent of moisture; but after they have cooled off they absorb moisture again from the air. To anneal a crucible properly, it should first be slowly heated to a temperature somewhat above 250 degrees Fahr., and it should be maintained at this temperature for a sufficient time to remove the moisture entirely. It may then be put into service, if it has been thoroughly annealed by the makers. If there is any doubt on this point, however, the crucible should next be heated for some hours to a dull red heat, after which it should be allowed to cool again, very slowly, to about 250 degrees. In any case the crucible should still be at a temperature of 250 degrees or over, when it goes into the furnace, or the drying-out process will not be wholly successful.

Treatment Depends on Size

Large crucibles, with thick walls, require a higher temperature than small-sized ones in the preliminary heat-treatment, and a correspondingly longer *soaking* period, in order to reduce the absorbed moisture to the allowable limit. In drying out a No. 200 crucible, for example, ten hours or more should be allowed for bringing it up to a temperature of 250 degrees Fahr., and fully ten hours more should be allowed for *soaking*. If a crucible that has a considerable amount of moisture in its walls is quickly subjected to a high temperature, the moisture will be changed into steam, and this, because it is confined within the walls of the crucible, may expand so as to cause a rupture or crack. The same result may also follow from the natural contraction of the drying crucible, if the moisture is driven out rapidly or unevenly. The small pinholes and *skelping* that may often be

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seen on crucibles are caused in this way. These pinholes and fissures form one of the chief sources of trouble against which users of crucibles have to guard; for although a crucible having defects of this nature may endure for a considerable number of heats, it is nevertheless likely to fail at a critical time.

After receiving heat-treatment for the removal of moisture, crucibles are often placed on a layer of damp sand, or on the comparatively cold furnace floor, and left there for an indefinite length of time before charging. This should not be permitted, because when the temperature of the crucible falls to a point materially below 250 degrees, it will again absorb moisture.

Alligator Cracks

Fine cracks, known as *alligator cracks,* often cover the entire surface of a crucible. These may be caused in a number of ways. Sometimes they are due to heating the crucible with fuel containing too high a percentage of sulphur; or, in oil furnaces, they may be caused by using too little oil or too much steam. It is specially important for the operators thoroughly to understand their work when using an oil furnace, because an excess of air or steam, or an insufficient supply of oil, may give rise to an oxidizing action, whereby a portion of the carbon or graphite is burned out of the crucible wall, leaving the binding clay in a somewhat porous condition; and this action, when it occurs, greatly facilitates the formation of cracks.

When crucibles are stored on the top of a furnace, the melters or furnacemen should make sure that the covers over the furnace openings fit properly. If the furnaceman is careless in this respect the moist gases that are given off when fresh fuel is placed on the fire will escape through the openings to some extent, and they are likely to come in contact with the crucibles, causing alligator cracks to form.

Cracks and fissures are also likely to form if the metal to be melted is not carefully placed in the crucibles. The men usually work rapidly when introducing the ingots, so that the furnaces will not be left open any longer than necessary; and the ingots are often thrown in with a force sufficient to indent the bottoms of the crucibles, or otherwise damage them. An indentation in a crucible, whether caused in this way or in any other way, is quite likely to develop, shortly, into a crack or fracture. The ingots should be introduced carefully and loosely, sufficient time being taken to insure that this is properly done. When a crucible is first filled it is desirable to place as many ingots in it, for the first melting, as practicable; but it is exceedingly important to see that they are not wedged or jammed, because when they are heated they will expand more than the crucible itself, and the walls of the crucible are likely to be cracked in consequence.

When a new crucible is put in service for melting, it should be heated quite slowly for a few runs, and this is *specially important* the first time it is used. After one or two runs it will become vitrified, and the danger from too sudden heating is then materially reduced. It is a good plan to keep on hand a few extra crucibles that have been used before, to avoid loss of time in case an extra crucible is needed on short notice.

A great deal of harm is done by carelessness in handling the tongs and shanks, and the life of a crucible may be seriously shortened in this way. When a tilting furnace is used, as many as 50 heats can often be obtained from a crucible; but if the heating is in furnaces from which the crucibles must be removed by means of tongs, they can be used for only about 15 heats, on an average.

A crucible is soft and plastic at a white heat, and may easily be squeezed out of shape by the pressure exerted upon it when the handles of the tongs are forced together. The walls of the crucible gradually become weakened by treatment of this kind, and eventually, if the crucible is not discarded, a complete rupture will probably occur, with its attendant toll of injuries and burns.

Three styles of tongs are in general use in foundries—one-pronged, two-pronged, and spade tongs. The different styles are designed for various special purposes and operations, but they are sometimes improperly used interchangeably. It is essential to see that the tongs that are used are of the proper shape, and that they fit perfectly from the widest part of the crucible, usually called the *bilge* or *belly*, down to within a few inches of the bottom. They should not extend to the *extreme* bottom, however, because this would make it hard to place the crucible in the shank. On the other hand, if they do not extend down far enough the crucible will be badly squeezed. The proper use of the tongs consists in taking hold of the crucible below the bilge and lifting it in such a way that the least possible pressure is exerted against the crucible walls.

Proper Tongs to Use

One-pronged tongs should be used only for lifting the smaller-sized crucibles, say up to size No. 40. For larger sizes two-pronged tongs should be used. It is not uncommon to see large crucibles, ranging from No. 200 to No. 300, lifted by one-pronged tongs. This practice should be condemned, because when one-pronged tongs are used for lifting a crucible, pressure is exerted against only a single point of contact, namely, at the bottom, and the crucible, when hot and soft, is likely to be cut or ruptured, if it is large and heavy, so that the pressure at the point of support is severe. Serious burns, from the spilling of the molten metal, often result when the lower prong of a two-pronged pair of tongs is cut off, on account of a lack of space between the crucible and the furnace wall, because the crucible is then lifted from above the bilge and tilted. Melters should be cautioned against the practice of driving down the ring of the tongs with a skimmer or other implement, because this is almost sure to cause cracks and fissures in the crucibles.

Reshaping Crucible Tongs

Molten metal is often spilled from crucible in consequence of using tongs that have become bent or otherwise misshapen. It is important to see that the tongs fit the crucibles properly, and that they are also in good condition in every other way. For restoring bent tongs to their proper shape, it is advisable to procure a set of cast iron forms similar in size and general shape to the crucibles that are used in the plant, but slightly larger from the bilge upward. To restore the tongs to their original form it is only necessary to put them in the furnace, raise them to a red heat, clamp them to the proper iron form, and bring them back into shape by means of a heavy hammer. Tongs may be fitted easily and cheaply in this way, and a great saving of time results. If cast iron forms are not provided, the blacksmith cannot be expected to restore the tongs to their correct shape with accuracy; but if iron crucible forms of the proper sizes and shapes are used, and the tongs are fitted to them as here recommended, the likelihood of squeezing and distorting the crucibles will be reduced to a minimum.

Two pairs of tongs, at least, should be provided for each size of crucible, so that if one pair becomes badly bent or worn, the other pair may be placed in service without loss of time.

Furnacemen should make sure that no clinkers or pieces of unburned coal or coke are stuck to the walls of the crucibles when about to grasp them with the tongs, because if the tongs are applied over a clinker the clinker will probably be forced into the crucible, and a rupture may then occur at any moment. It is also important to see that the bottom of the crucible, on the outer surface, is free from clinkers or other adherent substances, so that when the crucible is in the furnace its weight will be evenly distributed, and not concentrated at a few projecting spots or regions. It is best to support the crucible by means of a foundation or pedestal, of graphite, fire brick, or other infusible substance, though the fire bed may be made to give a fairly satisfactory support if it is carefully prepared and smoothed.

Buttons in Crucible Bottoms

When a heat has been poured it is important to see that no metal is left in the bottom of the crucible, because when a residual mass or *button* of such metal cools, it contracts at a different rate from the crucible, and serious strains and cracks are likely to result.

Ramming the fuel bed is bad practice, in general, because it is likely to damage the crucibles seriously. If ramming appears to be necessary at special times, the utmost care should be exercised in doing it.

Furnacemen, melters, pourers and helpers, should wear suitable protective clothing, consisting of congress shoes, leggings, and asbestos gloves and aprons. Wooden-soled shoes, or clogs, may be advisable, however, under special conditions. Eye-protectors or goggles, with lenses of colored glass, should be worn to shield the eyes from the glaring brilliance of the molten metal, and to prevent them from being injured by splashes.

If these various recommendations are conscientiously carried out there should be a radical reduction in the number of injuries, a marked extension of the service of the crucibles, and a saving of metal and money. The various precautions that we have suggested are of special importance at the present time because the European war has made it impossible to obtain the best materials for crucible manufacture, and it has, therefore, been necessary to make use of a large amount of native material that is admittedly inferior for this particular purpose. Hence the crucibles that are now being produced in the United States are of a somewhat lower grade, as a class, than the makers would like to turn out, and correspondingly greater care should be taken in handling them.

Navy Revises Steel Casting Specifications

The United States navy department recently has issued new specifications covering the manufacture of steel castings which supersede those issued June 1, 1916. The chemical and physical properties demanded by these specifications are given in the accompanying table.

It will be noted that the sulphur requirements are kept down to 0.05 per cent in all grades of castings except class C, for which no tensile, bending or other physical tests are required, and the sulphur content of this class is increased to 0.07 per cent.

The purposes for which each grade of steel castings is intended are indicated by the following:

Grade A is intended for all important parts subject to crushing stresses or surface wear only, such as hawse pipes, chain pipes, turret roller paths, engine guides, slippers, etc.

Grade B is intended for parts subject to tensile or vibratory stresses, such as stems, sternposts, stern tubes, rudder frames, struts, engine bedplates, cylinders, gun-mount stands, carriages, slides and other parts subject to the shock of recoil.

Grade C is intended for gun mounts, such as brackets, levers, wheels, etc., not subject to shock of recoil, and for commercial fittings where structural strength and separation of water-tight compartments are not involved, such as pipe flanges (other than bulkhead and deck), cagemast fittings, stowage lugs and clips, hinges for doors and hatches where watertightness is not involved, etc.

Grade D is intended for the same general purpose as grade B, but where greater strength is required with equal ductility.

Grade E is intended for castings for gun yokes, gun mount stands, carriage slides, deck lugs, etc., of large size.

The last specifications of the navy for structural steel work, dated Feb. 1, 1917, demanded not over 0.05 per cent sulphur and phosphorus in all steel castings used in yards and docks and similar work, and limited the sulphur to 0.045 per cent for riveting steel for bridges and buildings.

Steel casting manufacturers are experiencing considerable difficulty in limiting the sulphur content to 0.05 per cent owing to the increase of this element in pig iron due to the high pressure at which this material is being produced and also to the high sulphur content of the coke which now is being furnished to the blast furnaces.

Chemical and Phisycal Requirements of Steel Castings for the Navy Department

	Chemical composition, not over.		Physical Requirements.				
Grade.	Phosphorus, per cent.	Sulphur, per cent.	Minimum tensile strength, pounds per square inch.	Minimum yield point, pounds per square inch,	Minimum Elongation per cent in 2 inches.	Minimum reduction of area, per cent.	Bend test, cold bend not less than — degrees about an inner diameter of 1 inch.
F	......0.05	0.05	85,000	53,000	22	35	120
A	......0.05	0.05	80,000	45 per cent of tensile strength obtained.	17	20	90
D	......0.05	0.05	70,000		22	30	120
B	......0.06	0.05	60,000		22	30	120
C	......0.06	0.07	......		..	..	...

NOTE—Class F castings may contain nickel or other alloying metals.

How to Prevent Dull Iron

By *W. J. Keep*

Question.—We manufacture stove plate but our iron has not been sufficiently hot and fluid. Our cupola is lined to 30 inches inside and is equipped with four rectangular tuyeres, 3½ x 8 inches. Our heats average about 6000 pounds. We charge the cupola as follows: Four hundred and fifty pounds of anthracite coal and 110 pounds of coke on the bed, followed by the initial charge of 800 pounds of iron, with subsequent charges of 700 pounds of iron and 90 pounds of coke, the last charge containing 1000 pounds of iron. The blast is furnished by a fan operating at 2600 revolutions per minute at which speed the manufacturer claims it will discharge 3100 cubic feet of air per minute.

Answer.—Your melting ratio is 1 to 5, and, therefore, you are using sufficient fuel to obtain hot iron. If your furnace were equipped with two or three additional tuyeres the amount of air introduced would be considerably increased. If you find that the surface of your coke, when you begin to charge, is not 15 inches higher than the top of your tuyeres, add sufficient fuel to bring it to this height. You can reduce the subsequent charges to compensate for the additional fuel added on the bed. Ascertain the weight of the bed as described, and each subsequent charge should consist of 700 pounds of iron and 70 pounds of coke. We do not understand why you use anthracite coal on the bed since coke is a much better fuel and you can depend upon it to hold up the iron charges.

In one patented method of coating iron or steel with copper, a hollow ingot of the latter metal is first made by filling up a mold and the space left vacant is then filled with molten steel or iron, yielding a compound ingot which may be rolled or drawn.

Modern Methods of Gating Malleable Castings

A Study of the Problems Arising from the Action of Malleable Iron in Cooling Assists in Determining Correct Practice

By A M Fulton

CORRECTLY gating a malleable iron casting is just as important as securing a proper mixture of iron, and should have as much thought devoted to it as to any other feature connected with making the mold or pouring the metal. Irregular sections and sections joining at righ angles prevail to a large extent in malleable castings used in railroad car and heavy construction work. This condition causes an unequal cooling which creates shrinkage and checks at the heavy or adjoining sections. These conditions must be met by the foundrymen, and some manufacturers have made a big error in the past by overlooking this important feature; in many cases they were not absolutely sure that all shrinkage was eliminated. In recent years this difficulty has been eliminated to a very large extent, and today malleable iron is universally recognized as a valuable metal in construction work.

Many patterns are condemned if the loss of castings is above normal and the trouble is attributed to the design, it should have been charged up against the gating. Such criticism, for the most part, occurs when the foundry foreman is extremely busy and does not take time to think out his part of the problem.

Importance of Gating

Should the order call for sufficient castings, requiring metal patterns, the pattern shop foreman usually proceeds to make and gate the pattern according to his previous experience. But if he is in doubt as to the best location for the gate, this point should be discussed with the foundry foreman. These two departments should work in unison, having in mind the following points:

First, can the casting be fed from the proposed gate, excluding slag and preventing misruns?

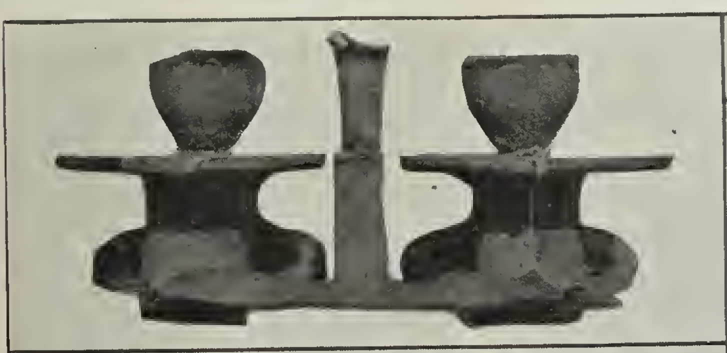
Second, should be heavy or unequal part be fed with a riser located at the top of the casting, as shown at Nos. 1 and 2, Fig. 7, or adjoining the heavy section as shown at No. 3, with a gate into a lighter part of the casting where the likelihood of shrinkage would not occur?

Chills Should be Avoided

Also there are times when we have such designs that the shrinkage can best be taken care of by the use of chills. If it is possible to eliminate chills entirely, it is better practice to do so, as the shrink-head takes care of any possible void, while the chill simply drives the shrinkage to a part of the casting where it possibly may do no harm. The use of properly proportioned heads correctly located will yield much better results than can be obtained from chills, and while the remelt will be increased somewhat, nevertheless, satisfactory castings are secured, providing a correct mixture has been used. All shrinkage is absolutely eliminated and there is no fear of "too hot iron" when heads are substituted for chills.

After tentative plans for gating are settled and molding has been started, it sometimes happens that trouble again arises, in which event the foundry foreman must alter his arrangements. A miscalculation may have been made in the location of the gate, or again, it may have been too heavy at the entrance into the casting. Should the former be the case, then a study should be made of the best point to relocate the gate, having in mind the two suggestions made in a preceding paragraph.

The malleable iron foundry is not unlike any other. It requires constant vigilance upon the part of the foremen of the various departments



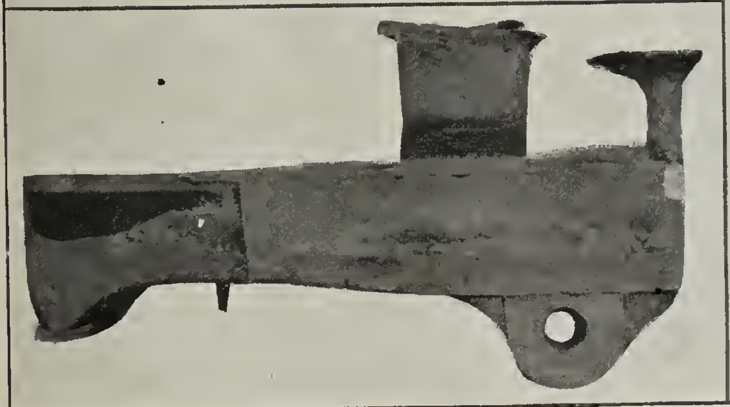


FIG. 1—HINGE-BUTTS WITH HEAVY HEADS
FIG. 2—COLUMN-POST GATED ON THE SIDE

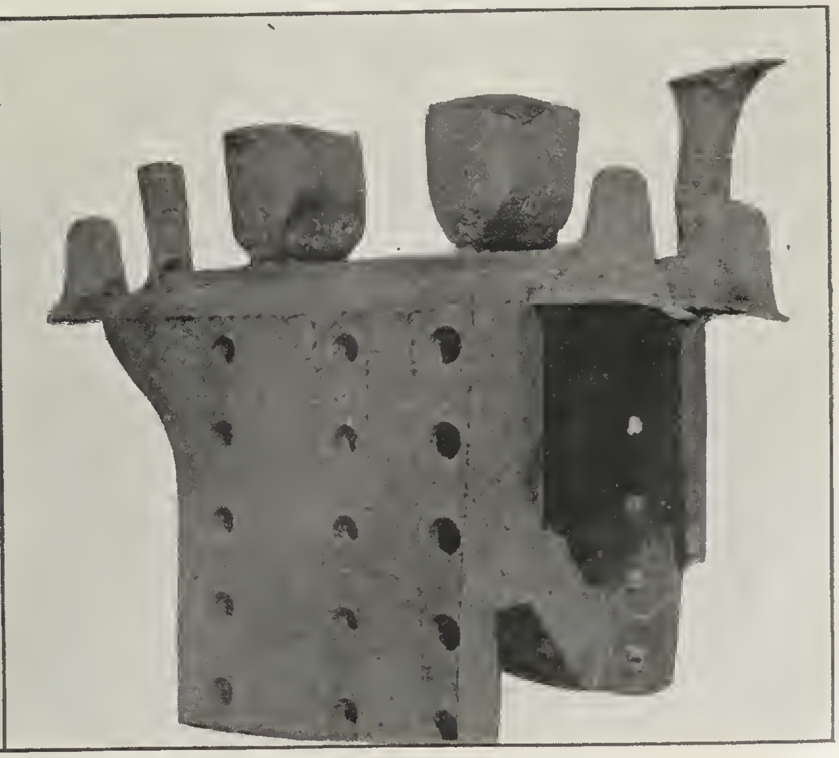


FIG. 3—HEAVY BOLSTER-CENTER FILLER CASTING WITH TWO HEADS

From a paper read at the Cleveland meeting of the American Foundrymen's Association, Sept. 11 to 15, 1916.

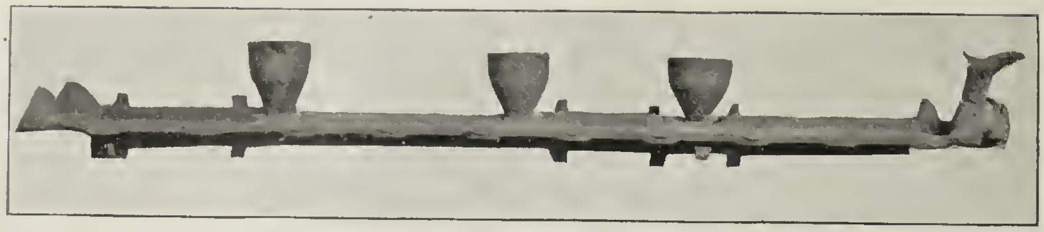


FIG. 4—CHEEK-PLATE WITH THREE FEEDING HEADS

to cope with losses due to shrinkage and to prevent their exceeding a normal amount.

In cases where a large number of small patterns are gated together and you are endeavoring to make as large a mold as possible, due to the light weight of the castings, do not lose sight of the fact that it is important to cast each piece successfully. This is a point that always should be borne in mind. Frequently you hear it said, "This pattern always misruns or shrinks." If too many patterns are gated together, or if they are not arranged correctly, and some pieces misrun or shrink, stop and think out the best method of changing the gate or decreasing the number of patterns to overcome this trouble. Do not continue to make castings in this manner, with high foundry losses, accompanied by increased production cost on the one hand and hidden defects on the other, as it is not only a loss to your business, but a detriment to the malleable industry as a whole.

Cut Out the Shrinkage Defects

Should the castings contain shrinkage defects in cases where the engineer who made the design based his calculations on solid sections, he certainly would be disappointed, as he would not secure the strength counted upon throughout the entire casting, and the piece might fail due to the existence of shrinks. It is essential that absolutely all shrinkage defects be eliminated. Failure to accomplish this end is many times the cause of a change from malleable iron to some other metal.

In order to give the reader a more comprehensive idea of the various methods of feeding castings, a number of diagrams, Fig. 7, are presented showing different designs for heads. A few illustrations of castings, with the gates and heads intact as they came from the sand, also are presented, no attempt being made to show anything special.

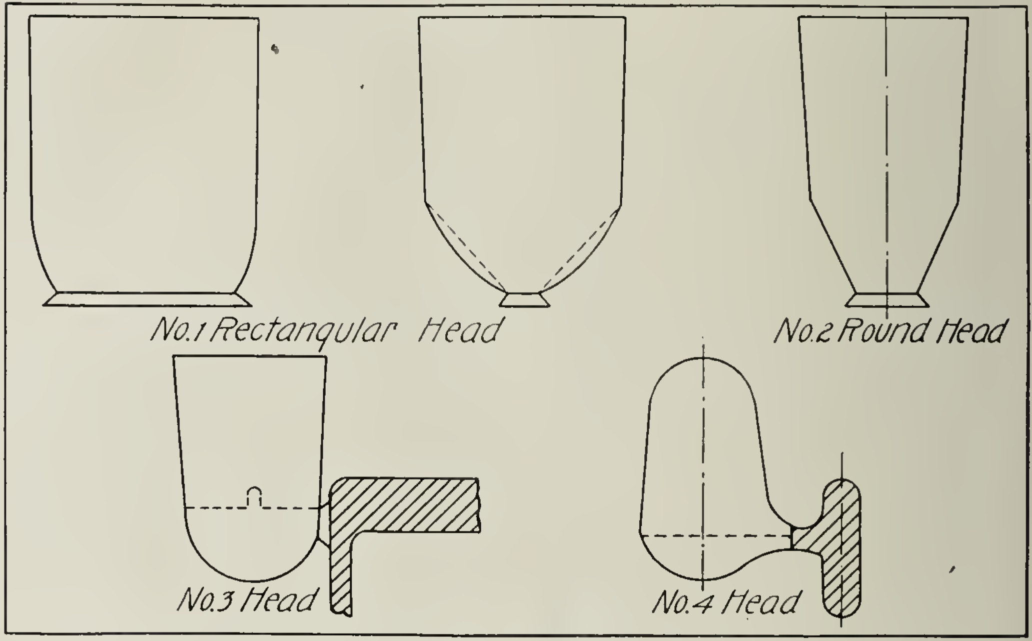


FIG. 7—DIAGRAM SHOWING DIFFERENT TYPES OF HEADS

In locating a head to feed a casting adequately, it should be placed at a point where the weight of the metal will feed down into the casting, as otherwise the head might rob the casting it was supposed to feed and thus cause shrinkage. In a case of this kind, the head usually should be placed over the heavy section and the gate located at a point where the section is more uniform. For instance, on a flat surface, the use of a design similar to No. 1 or No. 2, Fig. 7, should produce desired results. Should the design of a casting be similar to No. 3, which is a very unequal section, a head of the shape illustrated should feed the casting uniformly. The basin shown below the dotted line keeps the metal in the gate hot and fluid and prevents any possibility of chilling at this point, which would retard the feeding effect. Should we have a section similar to No. 4, Fig. 7, a feed-ball with a basin is satisfactory and in such cases proves very effective in eliminating shrinkage.

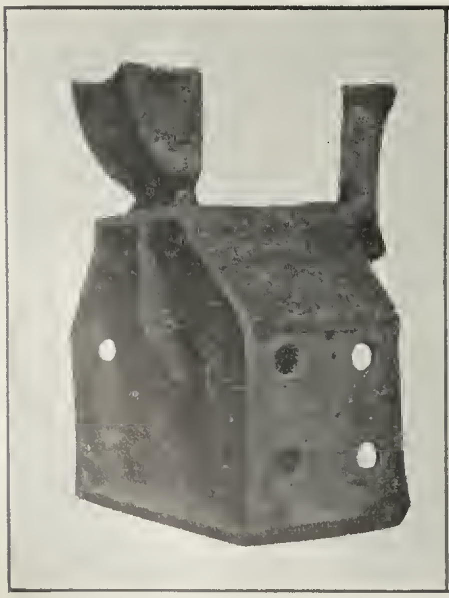


FIG. 5—BACK-STOP WITH A TROUBLESOME WEB

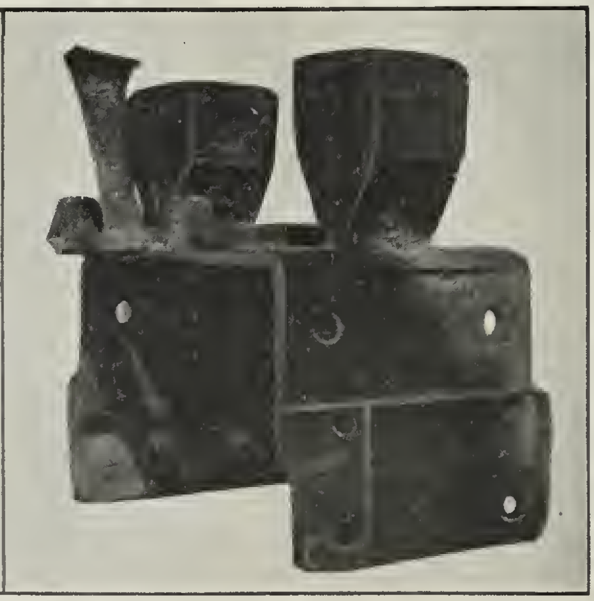


FIG. 6—CENTER-SILL SEPARATOR WITHOUT CHILLS

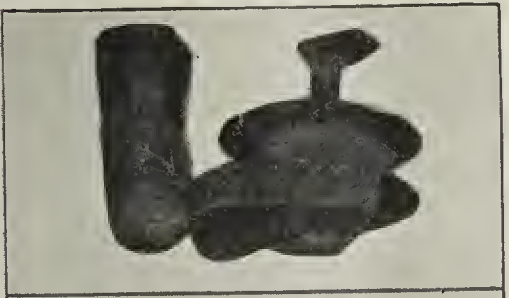
Gating Irregular Castings

Fig. 8 shows a very irregular sheave wheel casting, in which the sections are far from uniform. The rims are only ⅛-inch thick, the flange to which the head is attached, and the center of the casting range from 5/16 to ⅝-inch in thickness. The casting is gated over the center core with leads sufficiently large to admit the iron freely, yet keeping out the slag. The head in this particular casting is located at the bottom and feeds the casting thoroughly.

The sections in the side-bearing casting shown in Fig. 9 vary from 5/16 to ⅜-inch. There are a large number of angles giving excellent opportunities for shrinkage. Originally this shrinkage was taken care of by chills placed in the corners. These chills were eliminated when the head was substituted and an absolutely solid casting was the result. The head is so proportioned that the weight of the metal feeds down into the casting.

The hinge-butt, shown in Fig. 1, is of ½-inch section except at the location of the gate, where it is approximately 1 inch. There is a round head located on each casting which feeds down through the center web, eliminating all shrinkage.

The back-stop shown in Fig. 5 is of ⅜-inch section throughout, with a centrally located web. The construction is such that the center web is pulling against the outside walls during the cooling period. This unequal cooling is taken care of by the head shown in Fig. 5. This head has proven very effective.



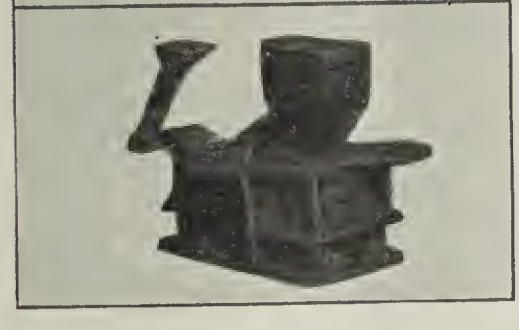


FIG. 8—A MALLEABLE IRON SHEAVE-WHEEL OF IRREGULAR SECTION

FIG. 9 — SIDE-BEARING SHOWING HEAD USED TO ELIMINATE CHILLS

In the center-sill separator, shown in Fig. 6, the metal thicknesses vary from ½ to 1 inch. At one time this casting was made with chills located around the center web, the metal being poured from the same gate as now shown in the photograph. The shrinkage was completely removed in this casting by changing from the use of chills to heads, with the elimination of all unsoundness.

The column-post, Fig. 2, is gated on the side opposite from that shown in the illustration with four leads into the mold. The head is located on the flat surface and successfully feeds the casting, eliminating all shrinkage.

The design of the cheek-plate, shown in Fig. 4, is such that it requires three heads to feed it. Also chills are located in each of the three slots. Due to the dimensions of these slots and the necessity for the distance between them being exact, it was decided to mold these castings with dry sand cores in the slots to facilitate the manufacture and reduce variations. The heads feed the casting very successfully.

A bolster-center filler casting is shown in Fig. 3. It will be noticed that this casting is considerably above the average size. The feeding is taken care of by the two heads shown in this illustration. These heads pipe for a considerable depth, which makes it certain that the casting is fed sufficiently.

There are innumerable malleable castings that do not require such measures as have been illustrated in this paper to insure soundness, because their sections are both light and regular, which gives the metal an opportunity to set quickly, thus preventing shrinkage. Such castings can be made successfully by using the style of gate in vogue for many years.

If the malleable founder will take care of his shrinkage by the location of heads so as to feed the casting wherever necessary, he can be sure of success in making heavy pieces with unequal sections. The practice greatly enlarges the field for malleable castings, and permits the engineer to design parts of much greater thickness than was believed possible in the past.

Chilled Iron Balls

By Edgar Allen Custer

In your July issue there is an inquiry as to the best way to make chilled cast-iron balls from 1 to 4 inches in diameter. It is obvious these balls must be cast in a chilling mold and a high chilling iron must be employed. The mold should be made of ordinary foundry iron and for a 4-inch ball should have at least 10 inches of metal outside of any portion that comes in contact with the molten iron. It should be equipped with a trap gate and an ample pouring cup. The accompanying sketches will show the general design.

The greatest difficulty that will be experienced will come from the presence of small dirt or gas holes, and these holes will invariably be near the surface and at the top of the casting. Their presence indicates that the trap is too small and must be enlarged. Small vent holes should be cut in the top of the mold running down to the matrix. These vents should not be more than 1/16 to ⅛ inch, and two will be sufficient.

If this mold is properly designed and operated, it is impossible to make a spongy casting or one that will have a coarse internal grain. The mold need not be preheated and can be used as fast as the metal can be brought and poured. It will chill as deeply when heated to 400 degrees Fahr. as it will at the room temperature. When the day's work is done, wipe the faces and matrix with a greasy rag. See that all the grease is cleaned off before starting on the next heat. Do a little machine work on the mold and make it so it will open and close easily and surely. Be prepared to pour as much iron in the trap as you pour in the casting. Never put more than two 4-inch balls in a mold.

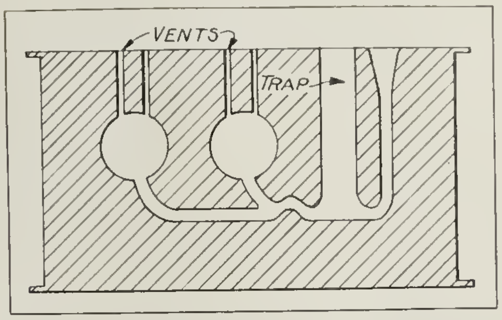


FIG. 1—ARRANGEMENT OF MOLD, GATE AND TRAP

If these directions are followed, there will be no difficulty in making clean and solid balls. A few pours will be necessary to determine the time the casting must be held in the mold to get the full depth of chill. Hold the first one five minutes and reduce this time by 15-second intervals until the low limit is reached. When the chill comes, it comes in a flash.

According to a British patent, aluminum or any light alloy can be protected from corrosion by sea water, by associating it with another aluminum alloy that is electro-positive to the alloy to be protected. Thus an alloy of aluminum with 5 per cent of zinc, it is claimed, can be used to protect pure aluminum, if used in the form of strips which are electrically contacted with the pure aluminum and submerged in the same medium as the latter metal.

A Norwegian inventor has succeeded in obtaining a patent in that country on a mold facing consisting of 98 per cent fine quartz or silica sand and 2 per cent fireclay.

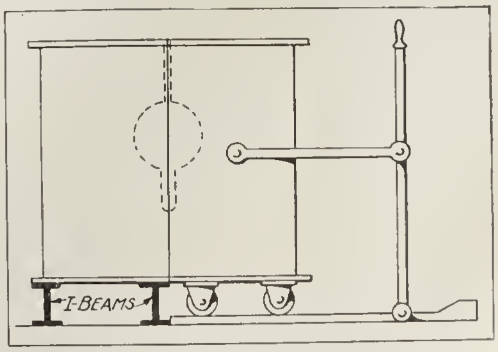


FIG. 2—ELEVATION OF MOLD IN POURING POSITION

Some Test Bar Suggestions For Nonferrous Metal

How Satisfactory Test Bars for Various Alloys May Be Cast —Different Types of Bars Indicate Widely Varying Properties

By Charles Vickers

WE HAVE discovered that no one type of test bar can be used universally, and that it is necessary to change the shape of the bar, and the method of gating and feeding it, to suit the different nonferrous alloys. For some classes of alloys a cast-to-size bar gives the highest tests, while in the case of others it has been necessary to select the test specimen from the lowest cast side of a heavy mass of metal to obtain a section sound enough to afford a suitable test.

It is doubtful whether any test bar is representative of the casting, whether attached as a coupon, or cast from the same heat separately, as the physical properties of the alloy, to such a large extent, depend upon the soundness of the metal, and this in turn upon the success with which the casting is supplied with liquid metal to fill up the vacancies between the crystals which shape themselves as the metal cools and contracts. Thus, it is possible to have a test bar that is sound because properly fed, and a casting to which the test bar is attached that is unsound, because improperly fed. The result is that the test bar is stronger than the casting and, consequently, fails to represent its quality.

The rate of cooling also may greatly influence the strength of the metal; as a general rule, slow cooling has a weakening effect; a test bar attached to a heavy casting will solidify before the casting, although it will be kept liquid by the proximity of the heavy mass of metal sufficiently long to give comparatively low values, but low as the value of the test bar may be, it will be higher than that of the casting to which it was attached. This applies more particularly to heavy castings. In the case of a thin casting it is highly probable that the test bar will give a lower value than the casting itself. This is especially true of aluminum and its alloys, and also applies, to some extent, to the copper and tin series. The reason for this is that a thin casting must be poured with hot metal to insure filling the mold, and it is this hot pouring that is so detrimental to the strength of this class of alloys. The casting, being of thin section, solidifies almost immediately, but the test bar cools more slowly than usual, because it was filled with hotter metal; the result is that its physical values are lower than those of the casting. In the case of the copper-tin alloys, the difference between the casting and the test bar, as a result of hot pouring, may be counteracted largely by properly feeding the bar, but for aluminum alloys this is not possible, with the result that the impaired physical properties of the test bar, due to its attachment to a hot-poured, thin casting, becomes a serious problem for the founder. A large, thin aluminum casting may require pouring at a temperature of not less than 800 degrees Cent. (1472 degrees Fahr.) to run it, while a test bar poured at this temperature will fail in the majority of cases to meet the specifications imposed for ordinary aluminum alloys. The result is that the casting is rejected with ensuing loss to the foundryman. To obtain a fair test in such a case, the test bar should be cast in a dry sand core composed of materials calculated to abstract the heat rapidly from the aluminum and cause the test bar to solidify as quickly as the casting. Every alloy has some peculiarity that influences the physical properties of the bars made therefrom, thereby rendering it difficult, if not impossible, to adopt any one standard method of casting such bars. Thus, the test bars for some alloys give the best results when cast with a longitudinal feeder, as illustrated in the course of this article, while other alloys may be cast more advantageously without the longitudinal feeder. In general, all alloys can be tested from specimens made from cast-to-size bars, and they all can be gated in a similar manner; but the feeders designed to insure the solidity of the casting must be differently disposed to obtain the best results.

The copper-tin alloys are deceiving in their shrinkage property, as it is more liable to be internal than external. In the case of the high shrinkage alloys, such as manganese and aluminum bronze, the shrinkage is external as well as internal and is exhibited on the castings in the form of hollows on the cope-cast parts, and cavities in corners. The finer the grain size of an alloy, the more it will shrink apparently; that is, the more liable the shrinkage will be to show on the outer parts of the castings. Such alloys are difficult for the founder to cast successfully as they require numerous properly-located risers to insure perfect castings. From an engineering point of view, however, the fine-grained alloys are the safest to choose for important parts of machinery as they are less liable to contain concealed defects than the coarse-grained alloys. The crystals in most copper-tin alloys are comparatively large and as the metal solidifies, a network of crystals is formed, shaped to the configuration of the mold. The

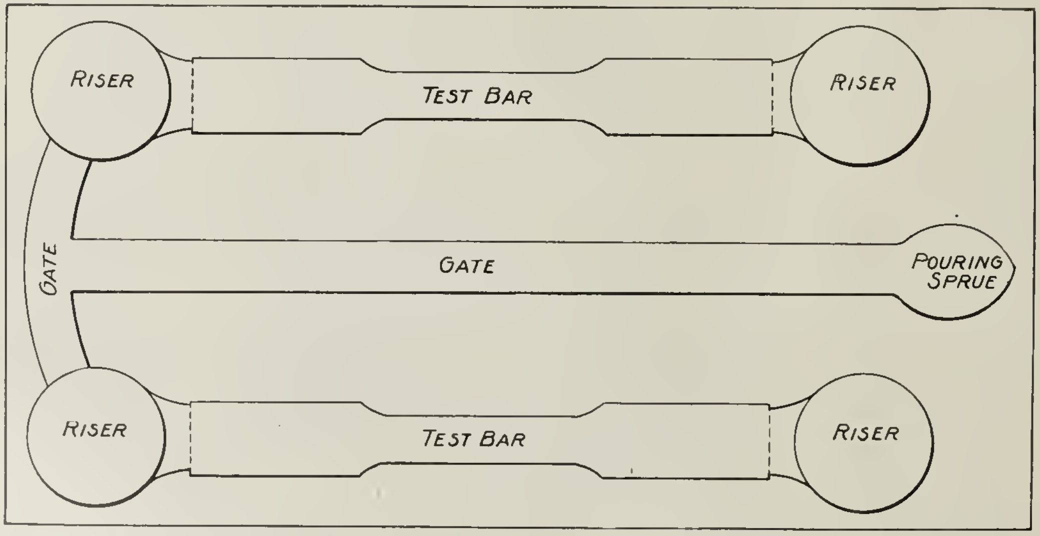
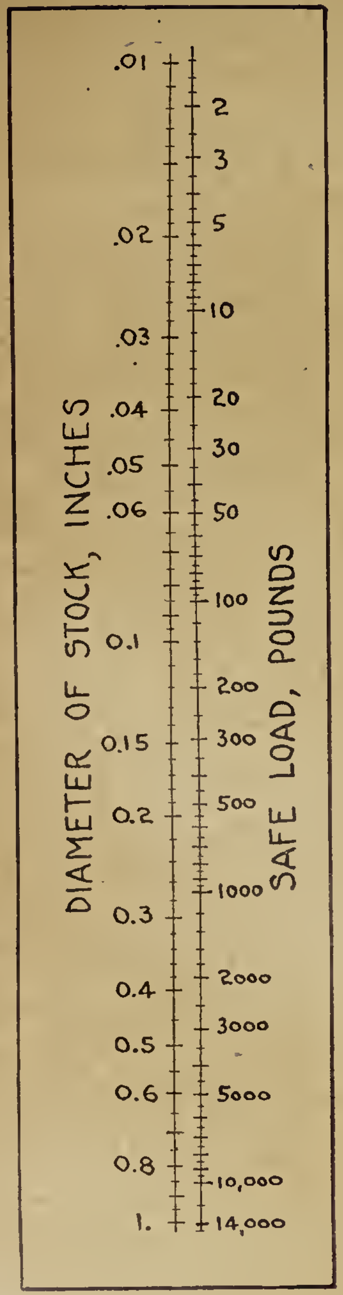


FIG. 1—METHOD OF GATING AND FEEDING ADOPTED WITH GOOD RESULTS FOR ALUMINUM ALLOYS

THE FOUNDRY DATA SHEET, AUGUST, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication



THE STRENGTH OF CHAINS

By N. G. Near

The accompanying scale for determining the safe strength of chains is based on the formula

$$W = 14{,}000\ d^2$$

where W = total load; d = diameter of stock in inches; and 14,000 represents a fair average constant for open link chain.

The safe strength of any ordinary stock may be determined by reading from the left-hand column to the right. If it is desired to find the size of stock required to lift a given load, read from right to left. Thus a 5000-pound load requires stock 0.6 inch in diameter. Stock 5/8 inch in diameter, the nearest commercial size, therefore would be used.

The Foundry, Data Sheet No. 239, August

WEIGHT OF SQUARE FOOT OF VARIOUS METALS

By George M. Carson

Thickness of Section (Inches.)	Gray Iron (Lbs.)	Wrought Iron (Lbs.)	Brass (Lbs.)	Copper (Lbs.)	Tin (Lbs.)	Steel (Lbs.)	Lead (Lbs.)
1/16	2.34	2.52	2.7	2.88	2.35	2.59	3.69
1/8	4.68	5.04	5.4	5.76	4.71	5.18	7.38
3/16	7.02	7.56	8.1	8.64	7.07	7.77	11.07
1/4	9.36	10.08	10.8	11.52	9.43	10.36	14.76
5/16	11.70	12.60	13.5	14.40	11.79	12.96	18.45
3/8	14.04	15.12	16.2	17.28	14.14	15.55	22.14
7/16	16.38	17.64	18.9	20.16	16.50	18.14	25.83
1/2	18.72	20.16	21.6	23.04	18.86	20.73	29.52
9/16	21.06	22.68	24.3	25.93	21.22	23.32	33.21
5/8	23.40	25.20	27.0	28.80	23.58	25.92	36.90
11/16	25.74	27.72	29.7	31.68	25.93	28.51	40.59
3/4	28.08	30.24	32.4	34.56	28.29	31.10	44.28
13/16	30.42	32.76	35.1	37.44	30.65	33.69	47.97
7/8	32.76	35.28	37.8	40.32	33.01	36.28	51.66
15/16	35.10	34.80	40.5	43.20	35.37	38.88	55.35
1	37.44	40.32	43.2	46.08	37.72	41.47	59.04
1 1/16	39.78	42.84	45.9	48.96	40.08	44.06	62.73
1 1/8	42.12	45.36	48.6	51.84	42.44	46.65	66.42
1 3/16	44.46	47.88	51.3	54.52	44.80	49.24	70.11
1 1/4	46.80	50.40	54.0	57.60	47.16	51.84	73.80
1 5/16	49.14	52.92	56.7	60.48	49.51	54.43	77.49
1 3/8	51.48	55.44	59.4	63.36	51.87	57.02	81.18
1 7/16	53.82	57.06	62.1	66.24	54.23	59.61	84.87
1 1/2	56.16	60.48	64.8	69.12	56.59	62.20	88.56
1 9/16	58.50	63.00	67.5	72.00	58.95	64.80	92.25
1 5/8	60.84	65.52	70.2	74.88	61.30	67.39	95.94
1 11/16	63.18	68.04	72.9	77.76	63.66	69.98	99.63
1 3/4	65.52	70.56	75.6	80.64	66.02	72.57	103.32
1 13/16	67.86	73.08	78.3	83.52	68.38	75.16	107.01
1 7/8	70.20	75.60	81.0	86.40	70.74	77.76	110.40
1 15/16	72.54	78.12	83.7	89.28	73.09	80.35	114.39
2	74.88	80.64	86.4	92.16	75.45	82.94	118.08
2 1/4	84.24	90.72	97.2	103.68	84.88	93.31	132.84
2 1/2	93.60	100.80	108.0	115.20	94.32	103.68	147.60
3	112.32	120.96	129.6	138.24	113.18	124.41	177.12

The Foundry, Data Sheet No. 240, August

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

crystals retain that shape when solid, unless the casting is of very heavy section, when the crust may sink and form a hollow. With castings of ordinary thickness, however, the exterior maintains the shape of the mold, because the solidified skin is supported by the large crystal formation while part of the interior is still molten, and as this solidifies, shrinkage occurs with the result that the casting may be satisfactory externally, but has shrinkage defects inside. This is due to the fact that after the formation of the skeleton of crystals, the metal inside continues to shrink as the various alloys richer in tin until all the liquid metal is consumed and no more is available to fill the vacancies that exist between the crystals at the center of the casting. The result is internal shrinkage which in flat castings, ½ to ¾-inch in thickness, is often manifested as a split and appears in the form of lemon-colored spots in castings of heavier section. Microscopic examination indicates that the lemon-colored spots consist of the same crystalline formation as the balance of the alloy, but minus the blue eutectic. Where the latter should have been there are voids, the crystals being attached to each other only at their more prominent angles. A test bar, therefore, taken from a portion of metal exhibiting these lemon-colored spots is comparatively weak, as the crystals of the metal, having slight contact with each other, are easily pulled apart. This is responsible for a large majority of the failures of castings to withstand hydraulic pressure. It also explains the popular belief that in the skin of a bronze casting lies its strength, for if we machine off the outer portion of a bronze bar, we remove the part that has been supplied with sufficient eutectic to firmly cement the crystals of the structure together.

Effect of Gating on Test Bars

A test bar of any of the copper-tin alloys, in the majority of cases, bears a most striking resemblance to a stick of elder wood so far as its internal structure is concerned, provided there has been failure to supply its central part with eutectic from some external source. This condition can be called upon to prevail in all cases where the test bars are gated or fed from the ends, because the central portions of the bars solidify too rapidly to permit of proper feeding with fluid metal to balance the shrinkage of the interior. For this reason, test bars of the copper-tin and copper-zinc series, that are gated with a fin gate possess much higher physical values than bars that are end-gated.

Table I

Physical Properties of Manganese Bronze From Cast-to-Size Test Bars

Heat No.	Ultimate strength, per square inch.	Yield point, pounds per square inch.	Elongation per cent. in 2 inches.	Reduction of area, per cent.	Remarks.
161	84,600	35,900	20.5	19.8	Two cast-to-size test bars with feeders. Tests poured from first heat of new metal immediately after proper pouring temperature was reached. New copper was used and Western spelter.
	83,100	33,300	23.5	23.7	
162	84,600	33,000	20.5	19.6	Two test bars cast-to-size made as nearly as possible the same as No. 161. The copper was 50 per cent new and 50 per cent scrap copper used entirely.
	82,700	32,100	20.0	19.4	
163	78,000	21,100	23.5	21.6	Two test bars cast-to-size made same as two previous heats, but scrap copper used entirely.
	78,300	22,500	25.0	24.3	

Analysis, approximate: Copper, 57.73 per cent; zinc, 40.45 per cent; manganese, 0.08 per cent; aluminum, 0.64 per cent; iron, 1.07 per cent; tin, 0.03 per cent; lead included with the zinc.

Test bars of aluminum bronze and also the light alloys of aluminum give the highest values when they are end-gated and are fed also with risers on the ends of the grips, as shown in the plan, Fig. 1. This is because all aluminum alloys are weakened more by slow cooling than by insufficient feeding.

The phenomenon attending the solidification of metals from a liquid to a solid state is a subject for study rich in possibilities for all who are interested in the casting of nonferrous metals and alloys. The smaller the crystals of an alloy, that is, the finer the grain, the easier it is to control its internal shrinkage and thereby secure castings possessing the maximum strength inherent in the alloy. As the crystals shape in a coarsely crystalline metal, they form a network, or project angles into the still fluid portion of the metal, and thus offer an obstruction to the passage of the more fusible portions of the alloy that makes it extremely difficult to feed metal to fill all interstices and thereby insure a sound casting. We frequently find that test bars, even when connected to a heavy, longitudinal feeder by a thick gate, when broken, display a small, unsound spot at the center, due to the lack of pressure and cool pouring.

Difficulty of Feeding

The difficulty of intercrystalline feeding has an important bearing upon the production of all bronze castings that are subjected to pressure, and this problem should receive careful consideration by every engineer when designing cast bronze machine parts that will be subjected to the pressure of liquids or gases. The only way by which intercrystalline feeding can be carried out with hope of success is by means of the hydrostatic pressure applied by sprues and risers of more than ordinary height, and sufficiently large in diameter to pre-

Table II

Physical Properties of Gun Metal as Shown by Differently Cast Test Bars

	A	B	C	D	E
Yield point, pounds per square inch...	19,700	14,700	20,100	21,000	22,600
Ultimate strength, pounds per square inch	35,100	18,700	36,900	24,400	50,000
Elongation, per cent in 2 inches.....	9.3	4.5	21.0	5.8	40.0
Reduction of area, per cent.........	9.0	1.0	17.2	2.0	34.2

HOW THE BARS WERE CAST

Bar A.—Machined from 1 inch round bar; cast horizontally with slight incline; gated at lower end of flask; sprue at high end and feeder on end of bar.

Bar B.—Machined from 1 inch square bar; cast horizontally with a 2 x 1-inch riser on center of bar where turned to 0.505 inch and gated at end farthest from sprue.

Bar C.—Machined from 1 inch square bar with 2 x 1-inch riser on center; gated on end and metal run directly into casting.

Bar D.—Machined from 1 inch square bar; cast vertically and drop-gated.

Bar E.—Cast-to-size bar with longitudinal feeder as illustrated in Fig. 2.

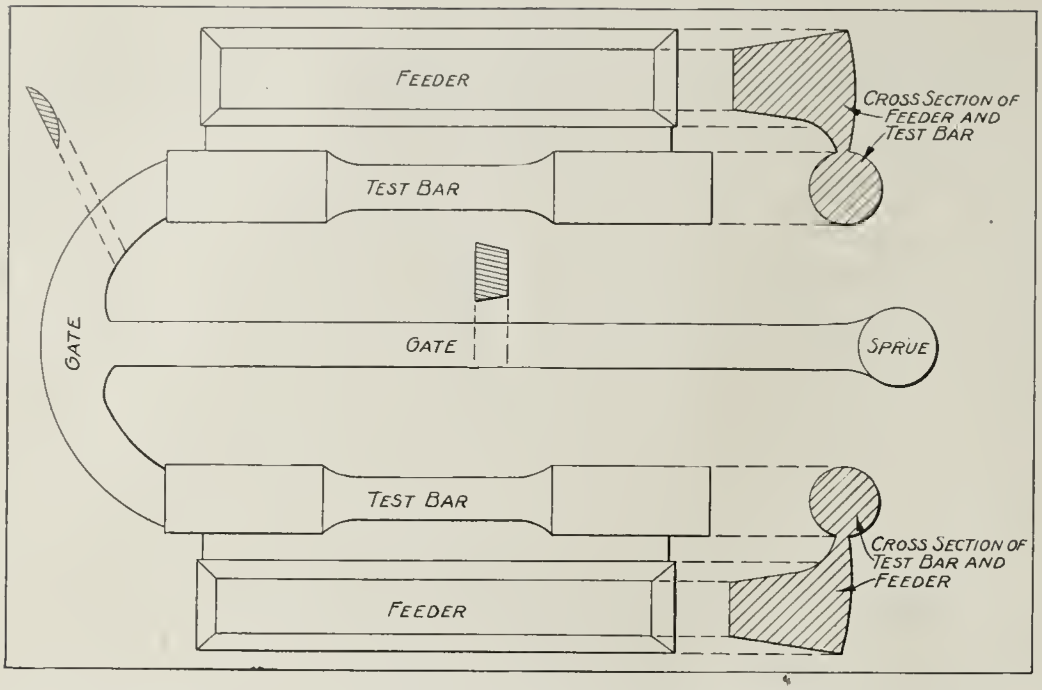

FEEDER
CROSS SECTION OF FEEDER AND TEST BAR
TEST BAR
GATE
GATE
SPRUE
TEST BAR
CROSS SECTION OF TEST BAR AND FEEDER
FEEDER

FIG. 2—A METHOD OF GATING AND FEEDING TEST BARS FOR MANGANESE BRONZE AND GUN METALS

vent the metal they contain from congealing before the casting cools. The drop-pouring process of casting is an example of this method of making bronze castings for pressure work. By this method, as practiced by one manufacturer, the height of the sprues and risers is 2 feet above the mold, which puts the casting under much greater pressure than if molded in the ordinary manner. The result is that 98 per cent of the castings are sound, whereas by the pursuit of ordinary foundry methods, the reverse is largely true.

Explanation of Pores in Bronze

There is another explanation of the pores or interstices between the crystals of cast bronze than the one here advanced. It assumes that their presence is due to the dissimilar contraction of the various copper-tin alloys formed during the freezing of the casting, or to the volume changes that are supposed to accompany the decomposition of the *beta* into the *alpha* and *delta* constituents as a result of the slow-cooling of the alloy. There are many difficulties connected with the casting of these alloys, however, that are better explained by attributing their lack of strength and porosity to an insufficient amount of cementing material between the crystals due to improper feeding Therefore, it will do no harm to give due consideration to this theory when important castings are to be made, and to adopt all precautions that experience may suggest to insure that all heavy sections of the casting have the opportunity to draw on risers or feeders of sufficient volume to eliminate the possibility of intercrystalline porosity to as great an extent as possible.

In making separately-cast test bars of such an alloy as manganese bronze, it is the customary practice to cast them on a mass of metal known as a. *keel block.* This block is illustrated at *B,* Fig. 4; its minimum size is about 4½ inches long, 3 inches wide and 4 inches thick. The coupons are cast on either side and one on the bottom, each 4½ inches long and 1 inch square. The casting and gate will weigh approximately 50 pounds. This is the minimum weight, as the grips are so short they must be threaded; therefore, if plain grips are preferred the keel block must be made longer, and it will require still more metal to make the castings. At *C,* Fig. 4, is shown a slightly different form of keel block that requires less metal than the former type and is easier to mold in cases where this type of bar is preferred. This pattern can be made from a piece of pine, 2 x 4 inches, and it carries two test coupons on the bottom, each 1 inch square, and as long as it may be decided to make the test bars. If this coupon block is poured on an incline with the gate running to the lowest point and the sprue placed at the highest point, with a riser 3 inches in diameter at the highest end of the casting, as shown in Fig. 4, two test bars will be obtained that will give satisfactory tests for manganese bronze.

A much better form of test bar is illustrated in plan, in Fig. 2, and is adapted equally well for gun metals or for manganese bronze. It is a modification of the fin gate principle, and was devised by the writer to permit of making reliable, comparative tests of manganese bronze with a minimum use of metal, and without the necessity for machining the test specimens. When the test specimens are attached to keel blocks, as shown in Fig. 4, experimental work on manganese bronze alloys is expensive. After the casting is obtained the coupons are cut from the block, which is followed by the operation of machining them from 1 inch square to the standard test bar, 0.505 inch at the center and ¾-inch at the grips. Thus an immense amount of work is necessary to obtain a little test bar.

Simple Test Bars

As previously stated, the method of making test bars, illustrated in Fig. 2, can be practiced either with manganese bronze or any of the copper-tin alloys, with equally good results. It will be noted that the castings are gated at the end farthest from the sprue. The metal, therefore, passes down a long gate of rectangular section with tapered sides, set in the drag of the mold, and being divided at the end, runs into each casting at their ends. After partially filling the test bars, it flows through the longitudinal gate into the feeder located entirely in the cope next to each casting. Thus any dross that survives the passage down the long runner and enters the test bar molds, has a good chance of being floated into the feeder where it does no harm. The gate connecting the test bar and the feeder should be about 3/16-inch thick at its junction with the test bar, and this thickness should rapidly increase to its point

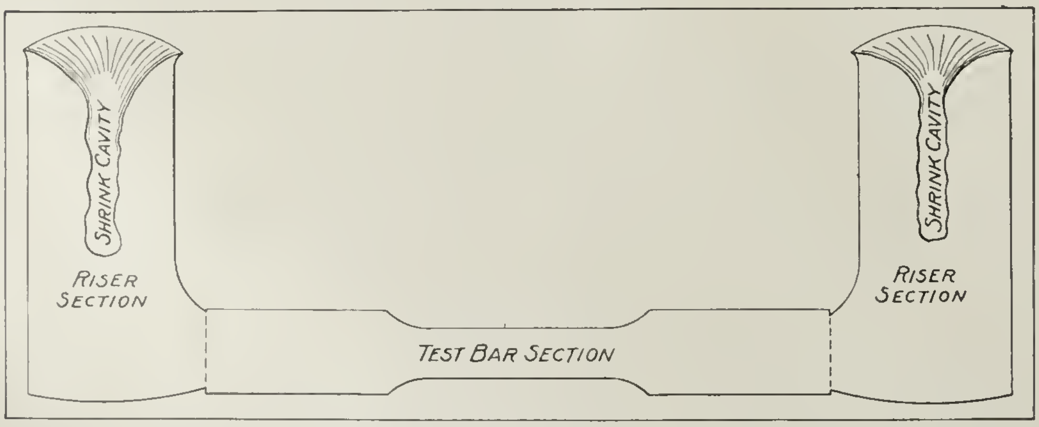


FIG. 3—LONGITUDINAL SECTION THROUGH A TEST BAR OF ALUMINUM BRONZE, SHOWING ITS RISERS

Table III

Difference in Physical Properties of Gun Metal When Cooled Rapidly and Slowly

Alloy, "Composition G.":—Copper, 87 to 89 per cent; tin, 9 to 11 per cent; zinc, 1 to 3 per cent, and phosphorous, 0.20 per cent.

	Heat No. 171.		Heat No. 172.		Heat No. 173.
Ultimate strength, pounds per square inch	43,200	45,300	44,200	47,300	32,400
Yield point, pounds per square inch.....	22,100	21,400	21,200	21,600	18,000
Elongation, per cent in 2 inches.......	27.0	33.5	29.0	36.5	20.5
Reduction of area, per cent............	33.0	32.8	31.8	33.0	21.4

Heats Nos. 171 and 172 were from cast-to-size bars as shown in Fig. 2. Heat No. 173 was cast into a keel block, such as used for manganese bronze and illustrated in Fig. 3.

of junction with the feeder. A flat fin gate of uniform section would be worthless and must be avoided, as it would promptly freeze and shut-off the flow of metal from the feeder to the casting. The riser is merely an elongated mass of metal of rectangular section that parallels the test bars as shown in Fig. 2, and while the illustration shows only one test bar for each feeder, in practice, one feeder will serve two test bars; one on either side of the feeder. The feeder should approximate a width of 1½ inches at the bottom, tapering to 1 inch at the top, thus allowing plenty of draft to facilitate molding. The length of the feeder will be governed by that of the test bars, and the latter will vary according as to the grips desired. The feeder can be about 1 inch shorter than the test bar.

A little more work is required to prepare fin-gated test bars for pulling than those gated on the ends, but it is not difficult to detach the castings, especially when a power saw is available. The bars are sawed off in line with the grips and the section of gate left along the thin portion of the bar is carefully ground, avoiding cutting into the bar, after which the latter is finished with a file. This method of making test bars requires a minimum amount of metal, as a heat of about 10 kilograms will pour one mold giving either two or four test bars, and such a heat can be handled easily by one man.

The tests recorded in Table 1 cover three heats of manganese bronze made from test bars that were cast in the manner outlined. In comparing test bars cast this way with bars machined from keel blocks it was found that the difference in physical properties as obtained by the two kinds of bars was so slight as to be unimportant. For research work especially, this type of test bar can be recommended for manganese bronze; it is also valuable in regular foundry practice as it enables quick control tests to be made of this alloy.

The following will illustrate the value of this type of test bar particularly in connection with research work. An alloy was made to conform to a new formula and in the first test the copper was melted together with a hardening alloy that would carry into the bronze all the desired constituents except the zinc, the latter being added in the form of spelter after the bath of copper and hardener was thoroughly liquid, which occurred without superheat. After the addition of the zinc which amounted to 41 per cent of the mixture, the alloy was stirred well. Every precaution was taken to prevent the bronze from flaring strongly, and as soon as the alloy showed zinc flares when its surface was disturbed, it was removed from the fire and was poured into the mold. The physical properties of the first heat follow:

Ultimate strength, pounds per square inch	88,400	90,600
Elongation per cent in 2 inches	20	25
Reduction of area, per cent....	26.8	24.9

After these tests had been obtained the alloy was remelted, flared for 15 minutes and recast into test bars with the following results:

Ultimate strength, pounds per square inch	89,900	90,000
Elongation, per cent in 2 inches	26	27
Reduction of area, per cent....	26.8	24.9

The foregoing physical properties would indicate that the formula, as devised, was excellent as determined by this economical method of making the test bars.

Tests of a Copper-Tin Alloy

In Table II the results are given of a number of tests of a copper-tin alloy made on bars differently shaped and cast, compared with bars cast with the longitudinal feeder. The alloy consisted of copper, 90 per cent and tin, 10 per cent in all of the tests. It will be noted that bars *B* and *D* gave very poor values, and there is little doubt that the difficulty with all the bars except *E*, was due to unsoundness at the core which was accentuated by the fact that all the strong outer skin had been eliminated by the machine work necessary to turn them. The 2 x 1-inch riser that was placed on the horizontally-cast square bars was too small to do much feeding as it solidified more quickly than the bar to which it was attached. In the case of bar *C*, the feeder had a chance to function better, as the metal was poured directly into the molds, instead of having to run to the bottom and then back up. When the metal is poured on the cool side, even the fin feeder on cast-to-size bars will not entirely obviate unsoundness of the center, because the metal sets before the eutectic can soak through to the core. This unsoundness is exhibited as a yellow center which materially affects the strength of the bars.

The following test of an alloy of copper, 88 per cent; tin, 10 per cent and zinc, 2 per cent, was much lower than it should have been for this alloy and this method of casting the bars, owing to the yellow centers. The physical properties follow:

Ultimate strength, pounds per square inch	44,600	45,000
Yield point, pounds per sq. in...	23,600	21,800
Elongation, per cent in 2 inches..	23	23
Reduction of area, per cent....	26.8	24.9

An alloy of copper, 88 per cent; tin, 10 per cent and lead, 2 per cent,

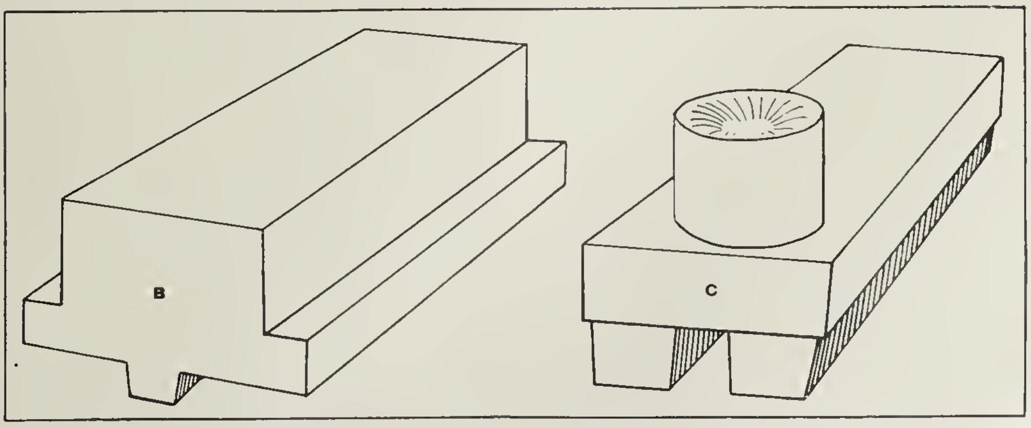


FIG. 4—TWO TYPES OF KEEL BLOCKS FOR OBTAINING MANGANESE BRONZE TEST BARS

with yellow centers, gave the following values:

Ultimate strength, pounds per square inch	42,200	41,100
Yield point, pounds per square inch	24,500	23,600
Elongation of 2 inches, per cent	17.5	17.5
Reduction of area, per cent	16.1	19.7

Where a very exact test is required and it is advisable to use machined test bars, the longitudinal feeder system can be relied upon to give excellent results. In the following tests a round bar was used for patterns. Its diameter was ¾-inch throughout, and it was cast with the side feeder and longitudinal gate, and was afterwards machined to proper standard size. The alloy consisted of copper, 80 per cent; tin, 5 per cent; lead, 3 per cent, and zinc, 2 per cent. The bars had the following values:

Ultimate strength, pounds per square inch	35,000	36,000
Yield point, pounds per square inch	16,800	17,000
Elongation, per cent in 2 inches	30.5	33.0
Reduction of area, per cent	28.2	28.3

In Table III are given tests which illustrate the effect of slowly cooling the copper-tin alloys. In all the tests the bars were sound to their centers. Heats Nos. 171 and 172 were cast-to-size bars and heat No. 173 was a keel block, the coupons from which were machined to size. It will be noted that the weakest bar of the cast-to-size series is 25 per cent stronger than that taken from the keel block, and it possesses 26 per cent greater elongation.

The tests given emphasize the fact that if it is necessary, in order to obtain the highest physical properties of the metal in a test bar, to connect the latter to a comparatively heavy feeder and also to insure a rapid rate of cooling, the judicious use of feeders is equally essential to obtain soundness in any important casting. When the latter is of heavy section and high physical properties are demanded, efforts must be directed to hasten its solidification by the incorporation in the mold structure of substances of higher heat conductivity than ordinary molding sands. This feature has received little attention in the manufacture of bronze castings, although it is practiced in casting aluminum alloys. The importance of insuring the more rapid solidification of the metal than is obtained in an all-sand mold has long been recognized by ironfounders, so that it is not unusual for large iron castings to be made in molds that abstract the heat from the molten iron more rapidly than is possible with sand alone.

In Fig. 1 is illustrated a method of casting test bars that has proved its value for aluminum alloys, including aluminum bronze. For such alloys it has been found that the proximity of the heavy side feeder retards the cooling of the test bars to such an extent that its influence in promoting solidity is more than offset by the slow cooling its presence entails; therefore, better results are obtained by placing risers on the ends of the grips as shown. In Fig. 3 is illustrated a cross-section through an aluminum bronze test bar. The risers, it will be noted, are massive compared to the casting, and contain deep shrinkage cavities which is characteristic of aluminum bronze when sound. Whenever this alloy is permitted to cool slowly its structure is changed and it loses all its more valuable physical properties. Therefore, it has been found that a different disposition of the feeders is required than in manganese bronze and the gun-metal alloys.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Core Sand for Brass

We would like to have a core sand mixture for brass castings which will satisfactorily resist the metal. We generally use an oil sand mixture, but have tried core compounds and resin with unsatisfactory results.

If the castings are heavy, that is, if the cores are surrounded by one or more inches of metal, an excellent core can be formed by silica, or any good, refractory sharp-sand bonded with linseed oil. The core should be baked to a nice brown color as is usual, and when cold, should be coated with a good grade of plumbago mixed to a paste with weak molasses water. This paste should be rubbed onto the core, and should be given a polish like a stove. The core should then be warmed to drive off all the moisture. The metal will not penetrate such a core, because all the little spaces between the grains of sand are filled with the plumbago.

On the other hand, if the castings come rough inside and cores are small and the castings light, like plumbers' work, the cores are being made with too large a proportion of sharp sand, and the mixture should be changed to embody more molding sand in order to make a smooth core that the metal cannot penetrate. The cores should also be well rammed to produce a firm, smooth surface. The sand can be bonded with either rosin, oil or flour, as most convenient, as the bonding agent has nothing to do with the metal penetrating the core. This inconvenience is due to failure to protect the core with plumbago in the case of thick castings, and to using too coarse a sand in the case of small castings.

Mixture for White Metal Patterns

Will you kindly furnish us with a mixture for white metal patterns?

An excellent mixture for white metal patterns follows: Tin, 50 per cent, and zinc, 50 per cent. Where the minimum amount of shrinkage is required the formula is modified slightly as follows: Tin, 50 per cent; zinc, 49 per cent, and bismuth, 1 per cent.

Plaster of Paris in the Brass Foundry

Will you kindly let me know how plaster of paris should be treated to permit of its use for making bronze castings?

Plaster of paris is too expensive to permit of its use in the production of ordinary brass castings. This is not due so much to the cost of the plaster as to the expense of treating the molds to prepare them for the molten bronze. To make the molds, plaster is mixed with red brick dust in the proportion of two parts of dust to one part of plaster. Carborundum fire sand also can be used in place of the brick dust, as well as a number of other substances which possess refractory properties and are sufficiently open to permit the passage of gases. This method only is employed in making statuary bronze by the lost wax process which involves the making of a mold by casting a self-hardening refractory substance around a wax model and when the mold has hardened, the wax is melted out. The mold then is gradually heated until an approximate temperature of 1000 degrees Cent. is reached, when all of the moisture is driven out. The metal is poured while the mold is hot. The plaster of paris is the medium that binds the mold and when the latter is finished the plaster must be thoroughly dried, as otherwise the metal will not lie quiet in the mold.

Strong Aluminum Alloys

We read with much interest the Data Sheet published in the June issue of THE FOUNDRY, *entitled, "Strong Aluminum Alloys." We cannot understand, however, that no tin appears in the last analysis when 3¾ pounds were used in the hardener. We would like to get an alloy suitable for making pattern plates.*

The formula for the hardener referred to consists of 3¾ pounds of tin plate, no mention being made of tin. Tin plate is steel or iron coated with tin and it is employed to add iron to alloys, because the coating of tin protects the iron from oxidation while it is being introduced into the balance of the molten alloy. The amount of tin added in this way is negligible. This alloy is not suitable for match-plates as it is too soft. A more suitable alloy follows: Aluminum, 90 per cent; tin, 2 per cent, and copper, 8 per cent.

Castings Subjected to Water Pressure

We would like to have your suggestions for a bronze mixture that will withstand water pressure. We have experienced considerable difficulty with the following: Copper, 40 pounds; tin, 4 pounds; lead, 1 pound and 30 per cent manganese-copper, ½ pound. Out of four castings we have made, three developed leaks when tested. Subsequently, we added 14 pounds of yellow brass punchings, but without success.

Figured in percentages, the formula you have been using is approximately as follows: Copper, 88 per cent; tin, 8.8 per cent; lead, 2.2 per cent and manganese-copper, 1 per cent. As the composition of the 14 pounds of yellow brass added to the original mixture is unknown, it is impossible to compute how much zinc was added, but undoubtedly this was sufficient to disturb the alloy and make the castings leak.

We suggest an entire change of mixture as follows: Copper, 88 per cent; tin, 4 per cent; zinc, 6 per cent; lead, 2 per cent and omit the manganese-copper. This mixture has been used successfully for castings subjected to water pressure in government work, having successfully supplanted the 88-10-2 alloy for some castings. We believe that permission can be obtained to use this alloy and we suggest that in melting the mixture a flux be used in addition to the charcoal.

Remedying Brittle Bushings and Gear Blanks

The castings for bushings and gear blanks which we are making are brittle and lack uniformity. We melt in an open-flame furnace, test the temperature by pyrometer and pour at approximately 1960 degrees Fahr. We have experimented with deoxidizers and fluxes without satisfactory results. For bearings, we use an alloy consisting of copper, 85 per cent; tin, 10 per cent; zinc, 3 per cent and lead, 2 per cent. For other castings the mixtures consist of copper, 83 to 84 per cent; tin, 6 per cent; lead, 8 to 9 per cent, and zinc, 0.5 per cent. This alloy consists of one-half ingot metal and one-half turnings from our machine shop. The tensile strength of this alloy is 22,000 pounds per square inch, with an elongation of 8 per cent.

It is probable that better results will be obtained by changing the mixture slightly, and for bearings we recommend the following: Copper, 84.75 per cent; phosphor copper, 0.25 per cent; tin, 10 per cent, and lead, 5 per cent. For the other castings, figure the proportion of scrap so they work out approximately as follows Copper, 87 per cent; tin, 6 per cent; zinc, 5 per cent, and lead, 2 per cent. Judging from the low tensile strength, we are inclined to believe that your difficulty might be traced to the method of melting, but we are unable to guess what this may be. It is good practice to make up for the zinc lost by volatilization. Also, it is necessary to use a flux, but more than 6 ounces per 100 pounds of metal must be used. A sufficient amount should be charged to cover the surface of the metal to protect it from the products of combustion. This is the only province of the flux as it consists of fluorides, oxides and carbonates which cannot be reduced by the molten metals.

How to Prevent Pin Holes in Brass Castings

We are experiencing considerable trouble in producing satisfactory brass castings for plumbers' use. Our scrap is carefully selected, the metal being thoroughly covered with salt and fluxes throughout the melting operation, but notwithstanding this, the castings show pin holes when polished. These pin holes are near the gates and often look like slag or dirty metal.

We only can hazard a guess as to the cause of this difficulty. If it is due to the pin holes, these may be produced by pouring very hot metal into poorly-vented molds, molds rammed too hard, or molds made of sand that is too close which will not allow the vents to come off freely. Then again, it may be due to burnt metal and since you are using scrap which may not be first-class material, the difficulty might be traced to this source. Furthermore, the imperfections may not be pin holes, but probably might be due to zinc oxide which gets into the castings because the molds are not properly gated for this metal and perhaps the latter is being poured too slowly. This defect may be traced to almost a limitless number of other causes and we suggest that you definitely determine whether the trouble is really due to pin holes or to dirt in the metal. If due to the former, do not pour any hotter than necessary to run the castings, vent the molds with a fine knitting needle and do not ram them as hard as formerly. If the metal contains no aluminum, try the addition of 2 ounces per 100 pounds, pouring when the metal no longer smokes. Sheet brass clippings are satisfactory for this work and it is evident that if your trouble cannot be traced to the scrap, then it must be due to your method of melting or pouring. We believe that aluminum can be used in this mixture and if this is possble, it will correct all of the faults except one. This involves the dross which can be kept out by proper gating.

If aluminum cannot be used, pour the molds with sufficient force to keep the pouring heads full, even if some of the metal spills when they are filled. Exercise care to have the molds so well vented that when the gases come off, they will explode when the red-hot skimmer is inserted underneath the bottom boards.

Mixture for Oxyacetylene Torch Castings

Owing to the difficulty of securing brass castings, we are compelled to make those used for the oxy-acetylene torches which we manufacture. These castings are exposed to high temperatures and weigh approximately 4 ounces to 2 pounds. We are contemplating using natural gas for fuel and we have figured on building a furnace by placing a 20-pound crucible inside of a 50-pound pot and centering the heating torch underneath the bottom of the large pot. We would like to have you suggest the proper method of procedure and to advise us regarding a suitable mixture for these castings.

Gas, whether natural or artificial, is a desirable, clean fuel for melting brass and we recommend its use whenever possible. However, it cannot be employed in the manner outlined. A furnace properly constructed should be installed, together with a blowing unit.

An alloy suitable for castings for these torches, follows: Copper, 88.50 per cent; tin, 6.50 per cent; lead, 2 per cent and zinc, 3 per cent.

Progress in the Manufacture of Steel Castings

An Account of the Gradual Advancement of the Steel Casting Industry—Recent Attempts to Improve Quality of Metal

By Robert P Lamont

EVERY ton of steel produced by present methods may properly be called cast steel, but only a comparatively small percentage of this steel, in its final form, may be correctly described or referred to as steel castings. There seems to be a rather small margin of difference between pouring the molten metal into an ingot mold preparatory to rolling or forging it, and pouring the same metal into a mold in which it takes its final form and shape. Therefore, it does not seem as if it should require any great inventive skill to step from one process to the other. In principle it is a simple matter, but the practical difficulties were great and the development of the cast steel industry was correspondingly slow.

Because of this rather narrow line between the first stage of ordinary steelmaking and what is in a sense the final stage of making steel castings, it is difficult to point out any definite place and date at which it can be said with certainty, "Here is where the making of steel castings began." In the large volume of literature on the early history of steelmaking there are practically no references to steel castings. The expression *cast steel* is frequently used, but it refers in every case to the pouring of the metal into ingot molds.

The probabilities are that the first castings were of simple form, such as could be produced in metal molds, and were no more difficult to make than ingots. As more complicated shapes were attempted, the necessity developed for a different kind of mold. The art, if it may be so called, was no doubt a gradual development, and no single name stands out prominently as the inventor of steel castings as now produced.

Developing the Industry in Europe

However, there seems to be no question but that the credit for making the first steel casting belongs to Germany. In the report of our federal commissioner, William P. Blake, to the Vienna Exposition of 1873, in describing the exhibit of the Bochum Steel Works in Westphalia, this statement is made: "One of the special operations in this works is the casting of steel in molds, after the invention of the technical director of the works, Jacob Mayer." Although the process was not patented in that country, it remained for 10 years the exclusive property of the company and of those works in France and England which had obtained the rights to manufacture. The report continues: "Another specialty of these works is the manufacture of cast steel bells. We have not space to detail all of the advantages and virtues of cast steel bells." Their manufacture dates from 1851. As early as 1855, at the Paris Exposition, the bells of the company attracted general attention. The surprise of the inspectors at this new steel product, indeed the doubt as to the possibility of working steel in this way, was so great that they desired an inquiry to be made to ascertain whether these bells were really steel, as was represented, or whether they were made of cast iron. The result of the inquiry was the bestowal of the great gold medal by the jury of the Exposition upon the following grounds: "The exhibited bells are characterized by perfection of performance, and a very clear unmixed tone, which is as clear as that of the ordinary

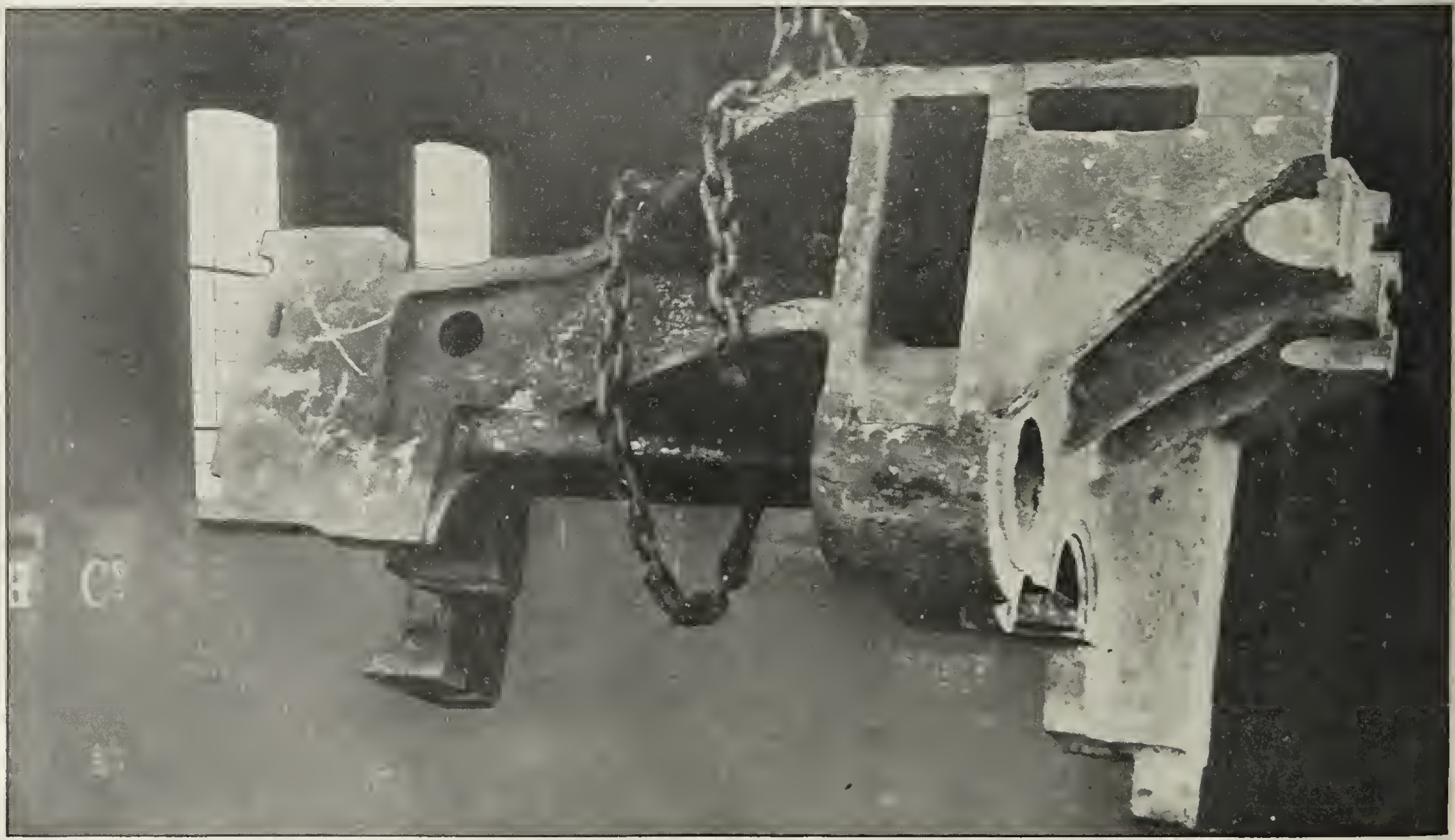


FIG. 1—CAST STEEL HOUSING FOR MILL OF LUKENS STEEL CO.—WEIGHT 24,045 POUNDS

Presented at the annual meeting of the American Iron and Steel institute. The author is president of the American Steel Foundries, Chicago.

bronze bells." As a consequence the jury came to the conclusion that the Bochum company, by its method of molding and pouring steel, had not only superseded bronze as the material for bells but had given a new direction to the manufacture of large forged and rolled pieces of machinery. The bells were cheap, costing about one-half as much as bronze bells; they were heavy, and since 1855 their manufacture had greatly and rapidly increased. In 1858 a test proved "that it is impossible with human power to crack one of these steel bells with heavy sledge hammers."

Made Steel in Crucibles

The steel in these early castings was melted in crucibles and cast in metal molds. Jacob Mayer is the only individual name mentioned in this reference to the early history of steel castings, but it is not clear from the report whether the technical director in 1873 was the originator of the industry which apparently started in 1851.

Immediately after the Paris Exposition of 1867 the Terre Noire Works of France, began a series of experiments to produce a metal to meet the requirements for projectiles for navy guns. They used a Siemens-Martin furnace, and the subject was gone into thoroughly from a metallurgical standpoint, probably for the first time. A number of irons were tried with the addition of a certain amount of steel scrap before casting. The results showed that the addition of scrap improved the iron, but the variations in the breaking points of the steel were found to correspond with the amounts of silicon it contained. If the addition of steel scrap was pushed beyond a certain limit, blow-holes began to appear. Experiments showed that projectiles made of this steel would not stand up in test. It was determined that to obtain steel without blow-holes, a proportion of 11 to 12 per cent of pig containing 3.5 per cent to 4.0 per cent of silicon should be added. This gave a hard metal and proved unsatisfactory. The metal was pasty, ran badly, and did not stand forging well. It was found necessary to add a certain amount of manganese in the initial bath, which made the slag sufficiently fluid to separate from the metal. It was of greatest importance to keep the oxidation as low as possible, and the process finally resolved itself to the employment of manganese and silicon in definite proportions and at regulated times. The metal was tapped directly into the molds, there being two tap holes, side by side, running into one spout fitted with two nozzles.

About 1870, this company was producing all sorts of industrial castings, such as cast steel car wheels, frogs, roll-pinions, etc. It was not until 1875 that the Terre Noire company produced a cast steel shell which would go unharmed through armor plate. By 1879 these works were producing 200 tons of steel castings per month, about half of which consisted of projectiles for the French government. The elastic limit of the steel was about 16 to 28 tons per square inch, with an elongation of from 2½ to 15 per cent.

At the Paris Exposition of 1878 the Hadfield Steel Foundry Co. of England, exhibited double spur wheels, railway crossings, wheels, pulleys, hydraulic cylinders, etc.

In the United States a few attempts were made during the civil war to produce small field pieces of cast steel. A number of steel works are reported to have made steel castings for their own use during this period. The best information indicates that the first steel castings produced in this country, which were of value commercially, were made in July, 1867, by the Wm. Butcher Steel works, which afterwards became the Midvale Steel works. These were crossing frogs for the Philadelphia & Reading railway and were made of crucible steel. This was before the adoption of silicon for solidifying steel, and the castings were honeycombed in all parts, except the wearing surfaces, which were solid and very smooth. The excessive sponginess of these castings, however, prevented their general use, although W. F. Durfee, who was superintendent in 1871, stated that they made quite a number of steel castings for reversible frogs, which weighed from 250 to 900 pounds.

In 1870 William Hainsworth of Pittsburgh, erected a small furnace having two crucibles, and made castings for the cutting parts of agricultural implements. He kept on experimenting until his capital was nearly exhausted, but in March, 1871, he incorporated a company and erected a plant at Pittsburgh. This was known as the Pittsburgh Steel Casting Co., and was one of the first steel foundries in the country. In making his molds Mr. Hainsworth used ground coke mixed with ground plumbago crucibles, German clay, which was tempered with glue water. On this mixture he took out a patent.

Open-Hearth for Cast Steel

In the latter part of 1874 Mr. Hainsworth had an open-hearth furnace constructed, which in 1875 was used in making steel castings. These, I believe, were the first steel castings from an open-hearth furnace in this country.

On April 28, 1876, the Midvale Steel Co. made two hammer dies of open-hearth cast steel, and the next month made a hammer head weighing 2535 pounds. The appearance of these castings was against them, as the surfaces were imperfect and the sand adhered to them in large quantities. There was also considerable trouble caused from piping and cracking.

The first use of the bessemer process for making steel castings is said to have been made by Mr. Hainsworth in 1881. One writer during this period states that castings of plain section, weighing 100 pounds, sold as high as 20 to 25 cents per pound. However, from 1867 to 1880 the output of steel castings was very small.

First Steel Casting Shops

A number of other plants now commenced producing steel castings. One of the concerns which achieved unusual success was Mackintosh, Hemphill & Co., Pittsburgh, better known as the Old Fort Pitt Foundry. It began the manufacture of steel castings by the Terre Noire process in 1881 and 1882.

In 1882 the Solid Steel Casting Co. was founded by J. K. Bole, S. T. Wellman, T. R. Morgan Sr. and S. J. Williams. The plant was erected at Alliance, O., and the first steel was made in 3½-ton open-hearth furnace. This is now the Alliance plant of the American Steel Foundries.

Another plant built about 1882 was the Standard Steel Castings Co., Thurlow, Pa. This firm first made castings by the crucible process, but installed an open-hearth furnace in September, 1884. They were unusually successful with large work, furnishing many steel castings for government vessels. This is now the Thurlow plant of the American Steel Foundries, and still turns out many castings for battleships, cruisers, and other large vessels. At the present time it has just finished all of the castings for superdreadnaughts PENNSYLVANIA and ARIZONA, and has on hand unfilled orders for castings for nine battleships and cruisers.

About this time, that is 1882, the business began to develop more rapidly, and in 1885 there were quite a number of successful plants in operation, among which may be mentioned: Solid Steel Casting Co., Alliance, O.; I. G. Johnston & Co., Spuyten Duyvil, N. Y.; S. G. Flagg & Co., Philadelphia; Chester Steel Castings Co., Chester, Pa.; Pittsburgh Steel Casting Co., Pittsburgh; Mackintosh, Hemphill & Co., Pittsburgh; Cowing Steel Castings Co., Cleveland; Eureka Steel Casting Co., Chester, Pa., and the Standard Steel Casting Co., Chester, Pa.

Much difficulty was experienced with molding sand in these early days, and it was claimed that the Midvale people, for instance, lost money regularly on steel castings for years while trying one mixture after another. At first a molding mixture of ground brick, ground pots and fire clay was used. The next step was to leave the ground pots out of the mixture, and to wash the mold

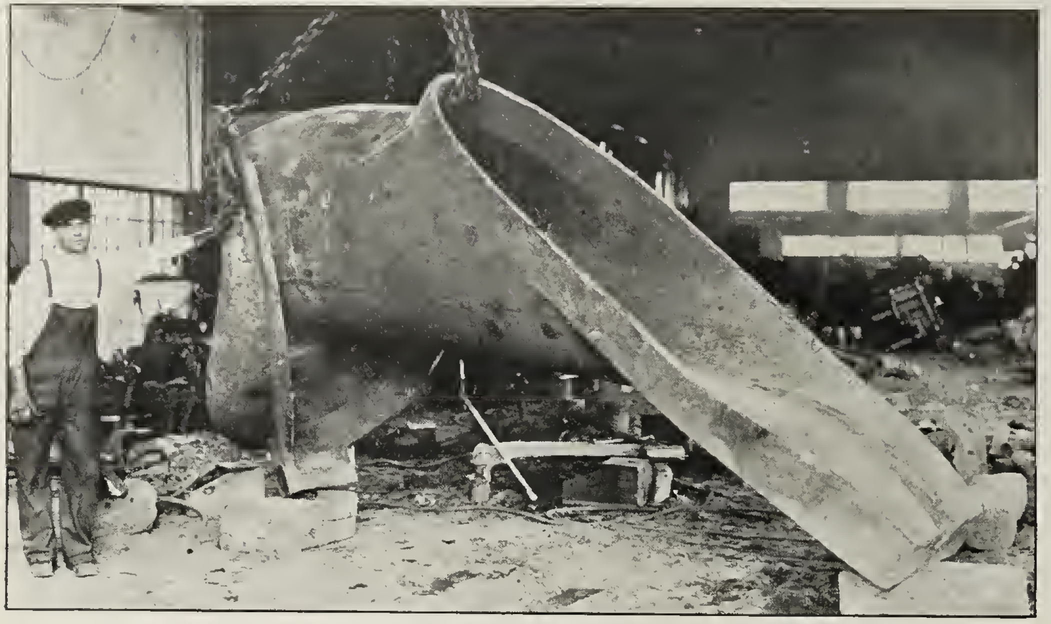


FIG. 2—CAST STEEL HAWSE PIPE FOR BATTLESHIP MISSISSIPPI—WEIGHT 12,930 POUNDS

with finely-ground clay fire brick. This made a marked improvement in the general appearance of the castings. However, the mold became hard, and intricate castings could not be made on account of cracks. Next, a mixture of sand and flour was tried, but there was a tendency for the flour to burn out. By 1887 a suitable mixture of sand and molasses had been obtained. George Cowing, of Cleveland, is credited with first making a mold for steel castings composed of nearly pure silica, glue water and molasses. At this time all molds were baked in ovens, but efforts were being made towards perfecting a process to allow the casting of small shapes in green sand. This was probably first attempted successfully by steel founders in the St. Louis district, which had now become quite prominent in the steel casting industry. In general, castings produced about this time were anything but satisfactory. In large castings, particularly, the earlier molds would burn onto the metal, or the metal would penetrate the molds in a spongy mass, requiring a great deal of labor and expense for chipping. Reference is made by writers in the 80's to pinions, weighing 13,000 pounds requiring two weeks to clean, and on which there was a piecework price of $2.00 per tooth. It must be remembered that at this time there were no pneumatic hammers. These first castings were hard, brittle, and not homogeneous. They were so full of blow-holes that one writer defined the ordinary steel casting as a rough chunk composed of about equal parts of steel and holes.

The shrinkage problem was more difficult than with gray iron castings, and it took years of patient effort to overcome the many difficulties involved.

Although the field for steel castings kept widening, they were not giving universal satisfaction. Their appearance was against them. Very few of the foundries had their own laboratories. In going over the history of the business during this period, 1880 to 1890, one gets the impression that the castings were pushed on the market before the art was fully developed, and with the result that steel castings fell into a certain disfavor which seemed to retard the progress of the industry for several years.

Our own government was one of the first to experiment with and make extensive use of steel castings in this country, especially for battleships. Between 1880 and 1890 the English founders were successfully turning out stern frames, rudders and stem pieces. Our own people apparently had not acquired the same skill, for in his report for 1890 Engineer-in-chief Melville, of the navy department, stated: "I am obliged to report we are having a most discouraging experience with steel castings." He further said that when the first new vessels were being built, the steel founders claimed that they could cast anything in steel that could be cast in iron, but that there was now (1890) a wide diversity among steel founders as to what shapes were practicable for casting in steel.

In 1887 congress passed an act calling for the manufacture of three cast steel, 6-inch, breech-loading rifles, to be made by the crucible, open-hearth or Bessemer processes, and to weigh approximately 11,000 pounds each. Only two were supplied, one of bessemer steel and one of open-hearth steel. In the tests the Bessemer gun failed at the second round. The open-hearth steel rifle was cast by the American Steel Casting Co., Thurlow, Pa., and was not submitted to any mechanical treatment after casting. Although it stood the statutory test of 10 rounds under service charge, there was a slight increase in the diameter of the barrel after the tests and the government rejected the gun. Failure of these tests caused a good deal of comment at the time and discouraged further efforts along this line.

Steel Casting for Railroads

Although at the present time a very large percentage of all steel castings produced in the country are used by the railroads, it is interesting to note that as late as 1885 very few were being used on cars or locomotives. At a meeting in Washington this year, the Railway Master Mechanics' Association devoted some time to a discussion of their use. A number of the members were using steel castings for cross-heads only, and on a few roads driving boxes, link hangers, eccentrics and rocker arms, in addition, were being made of cast steel.

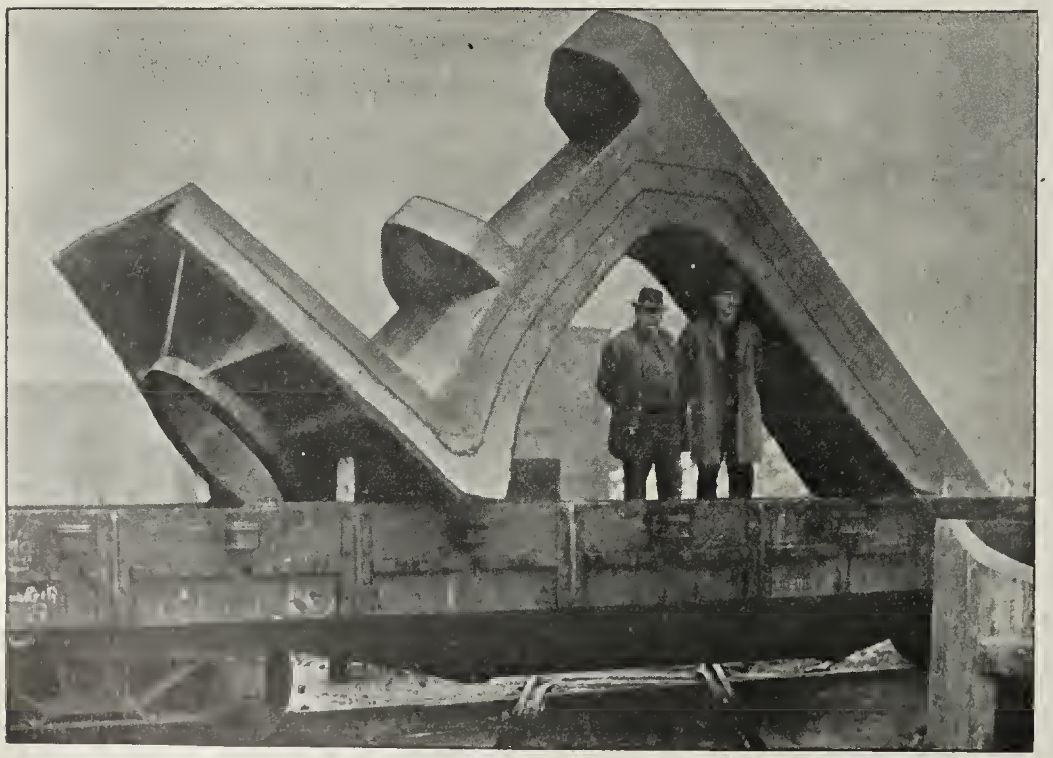


FIG. 3—CAST STEEL STERN POST FOR BATTLESHIP CALIFORNIA—WEIGHT 44,540 POUNDS

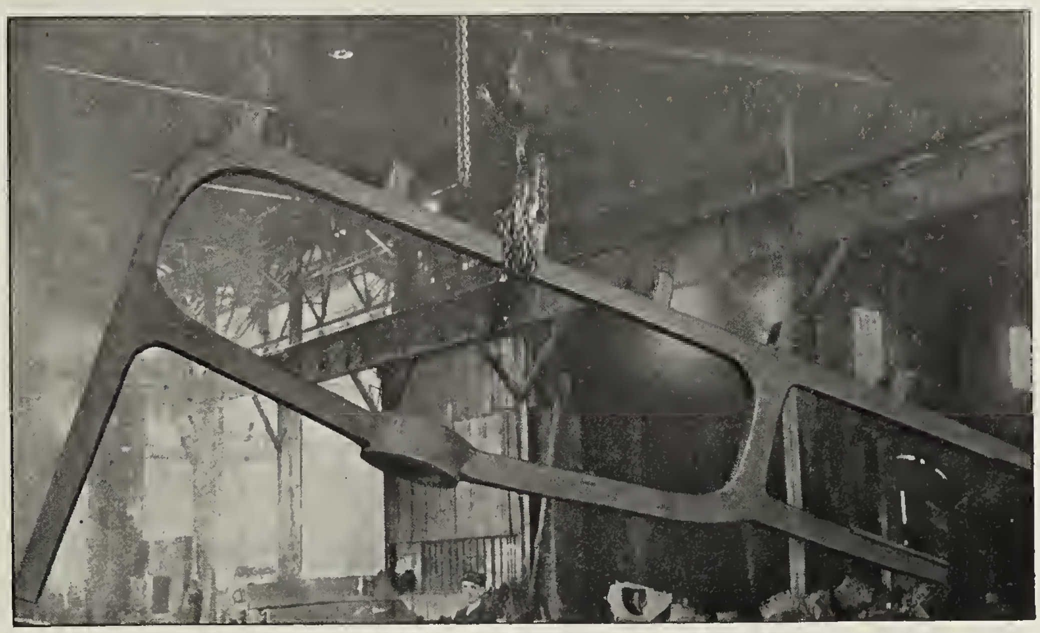


FIG. 4—LARGE STEEL CASTING INVOLVING DIFFICULTIES IN MOLDING

The Pennsylvania railroad specifications in 1888 for steel castings required a tensile strength of 70,000 pounds and an elongation of 15 per cent in two inches.

At the Chicago Exposition in 1893 there were exhibited by Krupp some steel castings which at that time were considered very remarkable, among them being a cast steel frame for a Pennsylvania railroad locomotive. At a meeting of the American Society of Mechanical Engineers at the time, doubt was expressed as to whether any American steel foundry could make such a casting. A contrary opinion was expressed to the effect that possibly three or four steel foundries in this country could make such a casting but that probably several castings would be lost before a successful one could be produced. Stimulated possibly by this exhibit and by the growing demand, American manufacturers soon demonstrated their ability to make these frames, for five years later they were being generally used. These first frames were light and of simple design, as compared with those now made every day as a mater of ordinary routine. At the present time frames are not infrequently 34 feet long, and weigh up to 14,000 pounds. The percentage of loss in a good foundry does not exceed four.

Development During Recent Years

During the past 20 years the development of the steel casting industry has been steady and rapid, although, of course, the production has had ups and down following general business conditions. Beginning with the nominal production of 1684 tons in 1883, by 1897 the production had increased to approximately 100,000 tons. Today there are about 200 steel foundries in the country, with a total rated capacity of approximately 2,000,000 tons, though the actual production given for last year was 1,286,509 tons. The production curve for steel castings for the past 20 years plotted alongside of one showing, for instance, the ingot production of the country shows a considerably more rapid rate of increase for steel castings.

While the product cannot even yet be said to be perfect, a great deal of careful, painstaking, intelligent study has been given to overcoming the difficulties in the processes, and it can at least be said that steel castings, to a large extent, have lived down the somewhat uncertain reputation earned during the first development period.

In this connection I think it not out of place to refer to the disaster to the center span of the great Quebec bridge on Sept. 11, last. Practically all of the early newspaper accounts, and even a good many of the technical journals which were published before a thorough investigation was made, gave as the cause of the accident the failure of a steel casting. One of the railway journals went so far as to say, "It was the well-known treachery of a steel casting." As many who read the first accounts may not have followed the matter further, I would like to read a short extract from an editorial in the *Engineering News* of Oct. 5, written after there had been ample time for a complete investigation:

> The rocker casting that broke was too weak by its very design. It was unsafe. So also were its three brother rockers. Because one of the four broke it has been called defective—it was rendered weaker than the others by some internal condition. But calling this one rocker defective does not mean that the other three were safe and adequate.
>
> The stress analysis presented on another page brings out the plain hard fact that the rockers at the time of failure were under very high stress. Figuring on neither the most favorable nor the most unfavorable basis of calculation, it is certain that the stress was higher than would be considered safe even in the very dependable rolled steel members of bridges. It was higher than the stress which the engineers of the Quebec bridge permitted in the rolled steel bars of the great chains by which the span was being lifted, although these had been tested so thoroughly that their large factor of safety was amply established.
>
> Moreover, the engineers knowingly allowed higher stress in the rocker castings than in the chains, although (by test) the chains could not fail until 60,000-pound stress was passed, while the ultimate strength of the rockers was entirely problematical. They allowed the high stress to be applied as a tensile stress to a thin projecting edge of a casting, where, if anywhere, a crack might have its origin. Even worse, the thin edge carried its highest stress at the root of a re-entrant right-angle corner of the casting, where the fillet had been notched to make a carefully fitted seat for a centering plate. This edge, also, was the top of the casting, where im-

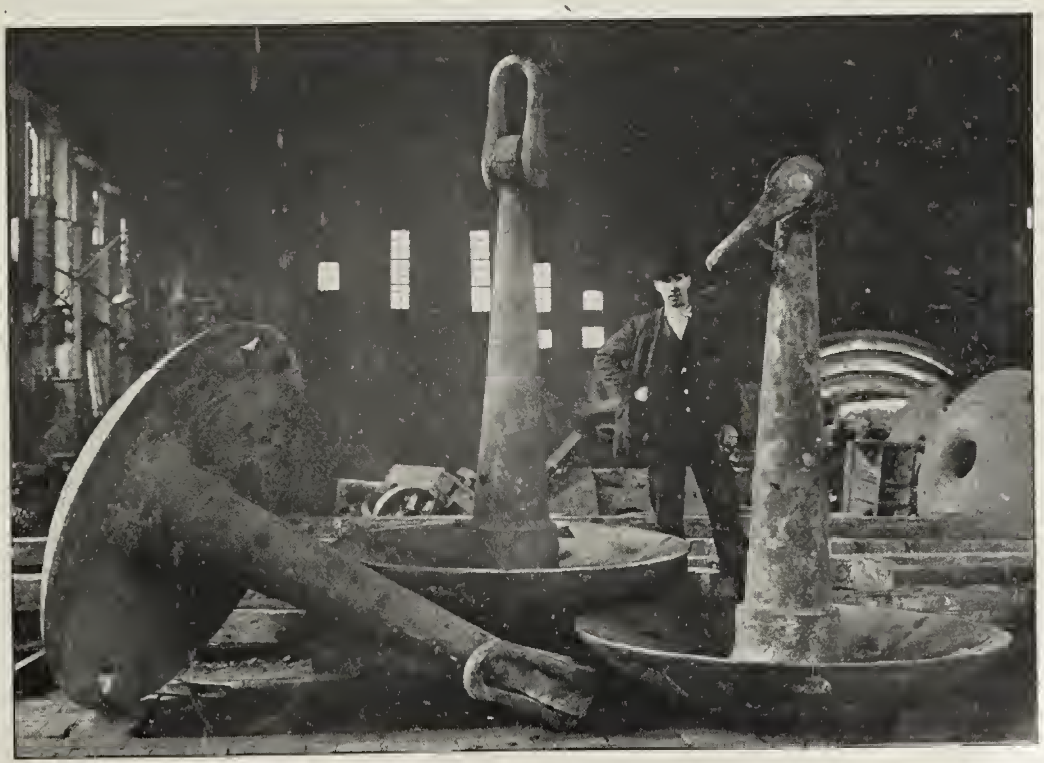


FIG. 5—MUSHROOM ANCHORS FOR GOVERNMENT LIGHTHOUSE SERVICE —WEIGHT 5000 POUNDS

purities often have a tendency to gather.

It was a clear case of a badly designed casting.

Of the approximately 2,000,000 tons capacity of steel castings in the country today about 52 per cent is for basic and 48 per cent acid steel. Almost 90 per cent is produced in open-hearth furnaces, 8 per cent in the converter and the balance by the crucible and electric processes. We have no accurate figures showing a division of tonnage as between dry and green sand molds, but the figures are probably not far from 60 per cent green sand and 40 per cent dry sand.

A comparatively recent important development in the industry was the introduction of the electric furnace. Steel melted in the electric furnace can be brought to almost any state of purity desired, and a very high temperature can be secured. The electric furnace will produce steel of as good quality and at lower cost than the crucible, assuming, of course, a reasonable price for current and sufficient demand to take the output of the furnace.

It is not necessary here to describe the difference between the acid and Bessemer methods, but it might be well to say that practically all machine castings, castings requiring any machine finish, are made of acid steel, while all miscellaneous car castings, such as bolsters, side frames, centerplates, couplers, etc., which do not require machining, are made of basic steel and in green sand molds.

Acid steel castings, particularly, if made in dry sand molds, present, as a rule, a better external surface and are freer from pinholes and surface defects. When you get below the surface, however, a test of basic steel will show just as good physical properties as the acid steel. The production of acid as compared with basic steel is less complicated from a mechanical standpoint, and is rather more generally susceptible of control in the matter of soundness or freedom from blow-holes. The fact that it takes about an hour, as a rule, to pour an average heat into steel castings, means, of course, that the slag is in contact with the top of the metal in the ladle just this length of time, and the basic slag takes up the silicon from the steel and in return gives up substantial amounts of phosphorus, with the result that the last metal to leave the ladle is inclined to be wild, resulting in porous castings, and sometimes a rather high percentage of phosphorus. This difficulty is not met in the acid steel.

Difference in Cost

There is, I think, a somewhat mistaken impression as to the difference in cost between acid and basic steels. At the present time low phosphorus pig, which is used in the acid process, is selling for about $80 per ton, and low phosphorus scrap $40 per ton, while basic pig is, say $42 at Pittsburgh, and heavy melting scrap about $32. Taking into account simply the difference between these figures, apparently the acid steel would be very much more expensive than the basic. However, when account is taken of the fact that a much smaller percentage of pig is used in an acid heat than in a basic heat—that the melting time is considerably shorter, the melting loss being about 2.5 per cent of the metals charged, and the life of the furnace substantially longer—the difference in cost is not great. At the present time, taking all factors into account, I should say that in the Chicago territory, for instance, the difference in cost is not more than $2 per ton, in favor of the basic steel.

Dry Sand and Green Sand Molds

The so-called dry sand mold is made of a mixture of silica sand and fire clay, modified in some cases with small percentages of rosin, dextrine or flour. After the mold is finished it is dried in an oven, which is kept at a temperature of about 500 degrees Fahr. for from six hours to six days, depending upon the volume of sand to be dried. This drying process, of course, ties up a large amount of flask equipment, requires a great deal of fuel and extra handling, and adds at least $1 per ton to the cost of the castings over the green sand method. In the case of large, rangy castings, such as stems, stern posts and rudders for battleships, the molds have to be rammed, then split into sections, which are dried separately, and finally fitted together on the dry floor before the casting is poured. Under ordinary conditions such a mold is in process of construction 10 days or two weeks before it is ready for the metal. In the case of the steamship PRINZESS IRENE, which went aground on the shore of Long Island, April 6, 1911, the steamship company was anxious, of course, to get the vessel back into the service as promptly as possible, and offered a liberal bonus for the completion of a new sectional stern frame in less time than was usually taken for such a casting. The record in this case was 11 days, and the bonus earned was almost equal to the price of the casting.

Green sand is composed of silica sand and silicious fire clay, in the proportion of about one of clay to 10 of sand, all thoroughly bonded in a heavy sand mill. These molds can be filled immediately after they are prepared, in fact, the sooner the better, for if they are allowed to stand unusually long, the cores take up considerable moisture, and in dry weather the sand mixture tends to lose its bond and disintegrate. The development of this green sand method of making a casting gave a great impetus to the business, on account both of reduced cost and of smaller investment required in plant and equipment. The problem of getting a proper molding mixture was the great difficulty confronting the early manufacturers of steel castings.

On account of the length of time it takes to pour an ordinary ladle of steel into castings, and because also many castings have thin sections, it is necessary to have a metal temperature at the time the heat is tapped of about 2800 degrees Fahr. The melting point of silica sand is about 3200 degrees Fahr., so that the margin between the temperature of the steel and the melting point of the mold is rather narrow. As a matter of comparison, the pouring temperature of gray iron is from 2200 to 2300 degrees Fahr., and of malleable iron from 2300 to 2400 degrees, which is well below the melting point of the mold, and the sand is not seriously injured; whereas, in a steel foundry the facing sand, so-called, which comes in contact with the hot metal a few times is practically destroyed, and can thereafter be used only for backing. If a good surface is required for castings, care must be taken in every case to see that only new sand is used where it comes in contact with the metal. In green sand work about 1500 pounds of new sand are required per ton of castings, and in dry sand the average is a ton of sand to a ton of castings.

The next great difficulty which confronted the manufacture of steel castings was to avoid shrinkage cracks. The contraction of cast steel is about $\frac{7}{32}$ inch per foot, practically double that of cast iron. To get an idea of what this means, a locomotive frame 34 feet long, for instance, will shrink or contract 6 or 7 inches in length in cooling from a liquid to a solid state, and provision, of course, must be made to allow this contraction to take place. A long, slender section of a casting, with flanges or projections at both ends, will invariably crack, and in extreme cases pull itself apart, unless the holding power of the mold against these flanges or projections is removed in time. It is important in the designing of steel castings to avoid, wherever possible, such a condition as this. It is equally important to avoid a sudden change from a heavy to a light section.

Use of Risers

Another great difficulty with the proper production of steel castings is the avoidance of pipes and shrinkage cavities. This can be done only by the use of risers or shrinkheads of sufficient size and number and properly located. In extreme cases the weight of metal in these risers—which must, of course, be cut off—equals the weight of the casting itself, and the average of net production of castings probably is not over 65 per cent of the metal charged. In green sand work, where the sections are thin and heavy risers are not used, the yield may, in some cases, run somewhat over 75 per cent. The cost of cutting-off these risers, and the fact that to produce a ton of castings requires from 1½ to 2 tons of metal, is a very large item in the cost of steel castings. Not infrequently these risers are necessarily located on a casting at points extremely difficult to reach with a cutting tool. In the last few years the use of gas cutting torches has greatly facilitated the removal of heavy risers.

Another difficulty which has long been difficult to overcome, the one which perhaps more than any other has been the cause of a good deal of the unfortunate reputation steel castings had in the earlier stages of the development of the business, was porosity — blow-holes so-called. There are many causes for this condition, among the principal of which are improper composition of metal, wet sand, too much carbonaceous material in sand mixture, poorly-ventilated cores, too rapid filling of the mold, improper gating, etc. The truth is, that the proper making of a steel casting calls for the coordination of a good many elements and compositions; if any one is imperfect, the effect is sure to be seen in the casting. And the difficulty is that in the handling of certain of these elements, no rules can be laid down which will satisfactorily guide an inexperienced man. Skill based on long experience is the only apparently sure guide. Of coure, the metal itself, up to the time it reaches the mold, is susceptible of pretty exact manipulation, but for the proper method of molding, and the location of gates and risers, there are apparently no rules that can be laid down.

Need of Annealing

After the casting is all but finished, it must be annealed to relieve possible internal strains due to irregular shrinkage in the casting itself, and the different rates of cooling due to variations of sections, etc. There has been a great deal of difference of opinion on this question of annealing. Some makers have gone so far as to claim that it was not necessary. A paper could be written on this subject alone. Our experience is that annealing is necessary; certainly it is in the direction of safety. The proper annealing temperature depends upon the carbon contents of the casting and ranges from about 1300 to 1500 degrees Fahr. for carbons from 0.20 to 0.90. The only certain method of determining whether a casting has been properly annealed is by a microscopic examination of a test piece broken from the casting. The time taken in bringing the casting up to the proper temperature and the rate of cooling are both important factors in the final result.

The past history of the industry has been about the same as that of most industries. The early experimental and development stage was difficult and unprofitable. In course of time a few successful businesses were developed and made money. After that there was apparently a too rapid expansion of capacity, excessive competition and no profit. Then followed the usual dropping out of the weak and the building-up of the strong companies. During recent years, when general business conditions have been good, I think the industry as a whole has shown a fair margin of profit. Following policies and methods suggested and practiced by this institute, the larger companies have been more inclined to work on a *live and let live* basis. We have been exchanging information as to methods, comparing costs, and undertaking in certain directions to adopt standard designs and specifications, all with the idea that by improving our methods and reducing our costs. we will broaden the field of the industry and make more work for the benefit of all.

Intelligent Use of Nickel-Plating Solutions

By E P Later

IN SPITE of the fact that nickel-plating has been practised for a great many years, and even at the present time is one of the most important and widely used of the various finishing processes, our knowledge regarding the mechanism of the operation is by no means complete and there are many points upon which further investigation is needed. In the early days of the art platers surrounded themselves and their work with a great air of mystery, and the most profound secrecy was observed in regard to the composition of the plating baths; each one had his own formula, and with the amount of doping with all sorts of things that some of those old baths received it is surprising that they produced a deposit at all.

There was almost no knowledge of the effect exerted by each of the various substances employed; in fact, this is one of the points on which our information at the present time is not so complete as might be desired, but in the course of time many of the substances which were added, perhaps more as a matter of habit or custom than anything else, were found to be either useless as far as conferring any beneficial effects was concerned, or even deleterious. Some of the constituents were gradually eliminated and the formulas for plating baths have been more carefully worked out until now there is a strong tendency to make the composition as simple as possible. We cannot go beyond a certain limit in this direction, however, inasmuch as experience has shown that a solution, in order to give the most satisfactory results, must contain various other substances besides nickel salts; therefore a knowledge of the action of different materials is of much importance, not only in producing the best and most efficient bath, but also in helping to correct the defects which arise from time to time and are often very troublesome.

Valuable Laboratory Tests

The results of an investigation of some of these points were reported a short time ago by Dr. Mathers and some of his co-workers, and it is believed that the facts which they have brought to light should be of much interest and help to platers; although the experimental work was carried out on a laboratory scale and all of the conditions might not be identical with those which are found in practice, there is little doubt that the conclusions which were drawn would apply, at least in a broad way, to nickel solutions operated on a commercial scale.

One part of the investigation was concerned with the advantages to be gained by the use of comparatively pure nickel anodes, as compared with the older style anodes containing about 92 per cent of nickel and 6 per cent of iron. For a long time it was thought to be necessary for anodes to contain a fairly large amount of iron to make them dissolve properly, but more recently anodes of higher purity have come into greater favor. These contain about 95 per cent nickel, 2.5 per cent tin, 1 per cent iron and smaller amounts of other impurities and are an improvement over the older type, but there seem to be certain disadvantages inherent to the use of anodes containing more than a very slight amount of impurities, which deserve mention here.

One of these is that unless all of the metal dissolved from the anode is deposited on the cathode the solution continually changes composition. Ordinarily the iron dissolved from the anode is either oxidized by contact with the air and precipitated out as a sludge, or it is deposited along with the nickel on the work which is being plated. The result is that, compared with the iron, the content of nickel in the bath decreases slightly, but through the removal of the iron in this fashion only a part of it, approximately one-half, can be deposited. Ordinary commercial deposits may contain upwards of 3 per cent iron, when anodes of high iron content are employed, and this exercises a deleterious effect, if only in the way of producing a dark, bluish-colored deposit, which is of course objectionable. Experimental deposits prepared so as to contain a considerable percentage of iron were less smooth than pure nickel deposits, also harder and more difficult to buff. It has further been claimed that nickel coatings containing appreciable amounts of iron tarnish and corrode more easily than purer deposits; this may often be a matter of some importance.

The aim of the plater is to produce as white a deposit as possible; blue or smoky deposits are not in high favor; therefore, if only on this score alone, it would seem that the use of anodes of high purity would be advisable.

The formation of a sludge in the bottom of the plating tank is annoying to say the least and may be the cause of more or less trouble. A deeper tank than would ordinarily be required for the work must be employed to afford a sufficient depth of liquid in order that that the parts may not hang down in the sludge, which would result in a rough, frosted deposit. Further, care must be exercised when putting in or taking out work to avoid stirring up the sludge, thus precluding the possibility of stirring or otherwise agitating the bath, so that a higher current density can be employed with consequent increase in capacity, and it is usually necessary to filter the solution occasionally to clarify it and keep it in good condition.

Cause of Sludge Formation

Sludge formation probably cannot be blamed entirely on the use of impure anodes. Some will form even if anodes of high purity are employed; consequently other means of combatting the trouble have been devised. One of these, putting the anodes in bags, which will retain any insoluble matter, needs no comment, but the addition of ammonium citrate to the bath may be considered briefly. This salt has the property of dissolving both nickel and iron hydroxides and therefore when added to a bath will prevent the formation of sludge entirely. In the investigation under discussion as little as 0.3 per cent was found to be sufficient to keep the solution perfectly clear and free from turbidity, although practical experience on a commercial scale might show the advisability of changing this amount slightly. The effect of suspended foreign matter in producing rough work is too well known to need more than passing mention here, and there is no doubt that any effective measures which may be taken to obviate this condition are generally well worth whatever trouble or expense their application entails.

Addition of Ammonium Citrate

The addition of ammonium citrate to a nickel solution means that all of the iron will be kept in solution, instead of part of it becoming oxidized and precipitating out, and nearly all of it will be deposited with the nickel, in consequence of which the deposit will be darkened considerably.

In connection with the use of pure anodes, the necessity of having some chlorine present in the bath in order to facilitate the solution of the metal was brought out in a rather striking manner by the fact that an anode efficiency of 99.71 per cent and a cathode efficiency 95.67 per cent at 13.9 amperes per square foot were obtained with a certain solution containing 2 per cent of magnesium chloride; while another bath identical in all respects with this, except for the absence of the magnesium chloride, showed an anode efficiency of only 17.5 per cent, while that for the cathode was 60 per cent. Either sodium chloride or nickel chloride may be used as the source of chlorine, although sodium exerts a harmful effect on the deposit and for that reason is a less desirable agent. Anode efficiency of more than 99 per cent was obtained with a single nickel salt bath containing a little less than 2 per cent sodium chloride.

Nickel baths vary rather widely as far as composition is concerned, and a good deal has been written on this subject, extolling the merits or pointing out the defects of some of the formulas commonly used, and the holders of opposing views have often defended them with considerable warmth. For example, the controversy regarding the respective merits of single nickel salts, as compared with the nickel-ammonium or double salt, attracted rather more than the usual amount of interest not so very long ago, and perhaps this is not strange in view of the fact that each has certain points in its favor. The so-called double nickel salt is particularly adapted in some ways for plating, and very good deposits may be obtained from it, but by reason of its rather slight solubility, the concentration of solutions prepared from it is comparatively low. This in turn means that the permissible current density is also low. The investigators found that a good deposit could be obtained up to 2.8 amperes per square foot, but with higher densities gas was given off and a *burned* deposit was produced. A number of different salts, magnesium sulphate, magnesium chloride, potassium chloride, and so on, were added in varying amounts, but they only reduced the current which could be used without burning, and it developed that boric acid was the only substance which served to prevent this at higher densities. Thus, with 5 per cent of boric acid in the bath, only slight burning was observed at a density of about 18 amperes per square foot.

The effect of increasing the nickel content of double salt baths, by the addition of various amounts of the single nickel salt, nickel sulphate, as might be expected, was to increase the current density at which good deposits could be obtained, and allow of a decrease in boric acid content. Thus the addition of 5.3 per cent of nickel sulphate with 1 per cent of boric acid made it possible to produce good deposits at 18 amperes per square foot; with 8 per cent of nickel sulphate considerably less boric acid, 0.3 per cent, was needed to prevent burning.

Baths containing both the single and double salts have found a rather wide use, and it was learned that one made up from 7 per cent of each of these, 1 per cent boric acid and about 0.2 per cent of ammonium citrate, worked satisfactorily at a current density of nearly 15 amperes per square foot.

Effect of Different Salts

Some interesting observations also were made on the effect of different salts on the deposit produced by this solution. It was found, for example, that an increase in boric acid content tended to brighten the deposit, but apparently did not affect it in other ways. Increasing the acidity of a nickel bath up to a certain point usually results in a brighter deposit. Just what the function of boric acid is may be open to question, but it is always used in nickel baths and aids very materially in the production of a good deposit; from 1 to 3 per cent is a satisfactory amount to use.

The question as to how boric acid functions and whether it may be replaced by other acids has been the subject of some investigation, and apparently there is a difference of opinion on this point. Mathers concluded that boric acid cannot be replaced by citric, acetic or benzoic acids, as far as the production of satisfactory results are concerned. It is the usual practice to keep the acidity of a bath below the point where it will affect the indicator known as Congo red, and it may be that the amount of these acids which were, or could be, added under the conditions was too slight to affect the working of the bath. It may also be possible that boric acid may exert some other effect other than producing a certain amount of acidity which these other acids are not capable of causing.

Magnesium salts have been found to produce a marked whitening effect on the deposit from baths containing nickel ammonium sulphate and even large amounts, 10 per cent or so, do not appear to do any harm. Potassium chloride, sodium chloride and sodium sulphate, on the other hand, when added in amounts up to 11 per cent, darken the deposit, the degree of darkening corresponding roughly to the amount of salt present.

Effect of Ammonium

It is peculiar, in a way, that nickel-ammonium sulphate apparently contains about the maximum allowable amount of ammonia consistent with good deposits, at least when anodes containing a considerable percentage of iron are employed, but this seems to be the case, inasmuch as decreasing the proportion of ammonium to nickel, by adding a straight nickel salt brightens the deposit; the darkening effect of sodium salts is likewise decreased at the same time. A nickel bath apparently can stand a small amount of sodium or ammonium, or both, without suffering any appreciable deterioration in the quality of the deposit, but when the sum of these has reached a certain ratio to the quantity of nickel present darkening is observed. The amount of sodium salt required to produce this effect depends, at least partly, on the amount of ammonium present; when this is high in proportion to the nickel only a comparatively small amount of a sodium salt will be needed to produce blackening, and on the other hand, when only a small quantity of ammonium is in solution, as compared to the nickel present, considerably more sodium may be added before serious darkening of the deposit takes place. In any case, the darkening effect of sodium is less than that of ammonium, and baths in which anodes containing much iron are used are much more susceptible than those fed from purer anodes, thus indicating that this difference in behavior is due to the iron present in the former.

An increase in the amount of boric acid will tend to lessen the darkening of the deposit by these salts, but the simplest and most logical way of avoiding the trouble would be to eliminate sodium altogether by using magnesium or nickel chloride to supply the chlorine necessary for ready solution of the anodes. If for any reason it is desired to use the double salts it will be advisable to add a certain amount of the single salts to the bath, as this will allow a more concentrated solution to be made, and the reduction in the proportion of ammonium may exert a further effect in the way of whitening the deposit. As a matter of fact, a bath with 4 per cent nickel-ammonium sulphate, 1 per cent boric acid, 0.2 per cent ammonium citrate and from 8 to 16 per cent of nickel sulphate gave the best results of any which were tested; the deposits were brighter after buffing and, as would be expected, the effect of the alkali metals in producing dark deposits was much less. It has the further advantage that the acid content need not be so carefully regulated as in the case with baths made up from the single nickel salts.

While we are considering the composition of nickel baths it may not be out of place to mention some of the work which has been done on the problem of nickeling zinc, inasmuch as it has involved considerable experimenting with solutions of varying composition. Zinc is finding a wide and increasing use in such household articles as cabinets, table covers and similar articles, while die-castings, which are made from zinc alloys, are being produced in large quantities and it is often necessary or desirable to give these parts a nickel finish. Little difficulty is encountered in coating the ordinary metals, other than zinc, with nickel, but zinc has given a good deal of trouble in this respect and much has been said concerning the causes and remedy therefor.

If a piece of zinc is immersed in a nickel bath, unlike any of the other metals, it quickly becomes covered with a black deposit which prevents the coating subsequently plated on from adhering, with the result that peeling-off soon takes place. This peculiar behavior is due to the fact that zinc is electro-positive to nickel and therefore tends to displace the latter from its solutions, going into solution itself as the nickel plates out in metallic, but very finely divided, form; the same sort of a phenomenon is observed when a piece of iron is placed in an acid copper bath. Ordinarily the electro-positive nature of zinc is a distinct advantage and is put to a good use in protecting iron parts from corrosion by coating them with zinc, as in galvanizing, but in this particular instance it is objectionable, and various means have been employed in the attempt to overcome it.

Coat Zinc with Copper

One simple way out of the difficulty is to coat the zinc parts with copper before nickeling; satisfactory results may thus be obtained, but it involves so much extra handling that the cost of finishing is increased unduly, so that this scheme is not without its disadvantages.

Hammond, another investigator, has recently made a study of this problem, and the facts which he has brought to light are worthy of note.

Plating solutions have been made up containing different salts which were added for the purpose of making the zinc less electro-positive to the solution. It has been found, however, that very little or nothing can be, or at least has been, done along this line, and all of such solutions which were examined produced blackening of any zinc parts which were immersed in them. Sodium citrate was found to lessen the rate at which this deposition of finely divided nickel takes place and so, to this extent, exerts a beneficial effect.

It is well known, however, that heat increases or promotes chemical action; so it would be expected that the temperature of the nickel bath would influence considerably the rate of deposition of nickel on the zinc, and direct tests have shown that this is the case. For instance, at 0 degrees Cent. immersion of zinc strips in a nickel bath for 45 minutes produced only a slight coloration; the intensity of the action increased steadily with increasing temperature, 20 seconds immersion at 90 degrees Cent. sufficing to produce a blue-black color on the zinc. Working solutions hot is not uncommon, and there is much to be said in favor of it, but it is apparent that nickel baths must not be used too warm when zinc is to be plated.

Increasing Chemical Action

Another way of increasing or promoting chemical action is to increase the concentration or amount of the reacting substances present, in consequence of which it would readily be inferred that the more salt a nickel bath contains the more rapidly would the nickel be deposited on the zinc; this is likewise the case. This explains, too, why all of the solutions which have been proposed for the direct nickeling of zinc are low in metal content and consequently can be employed only at relatively low current densities.

In order to determine the best conditions for the deposition of nickel on zinc, a large number of solutions of different strengths and compositions was tested; the content of nickel sulphate varied from somewhat over 5 ounces per gallon to saturation. Some of the baths contained only nickel sulphate, while to others a certain proportion of nickel chloride was added; still other baths were made up from mixtures of the two salts acidified with various acids. The current density likewise varied widely, ranging from about 1.8 amperes per square foot to 140 amperes per square foot.

The result of this work was to show that nickel can be plated directly on zinc from a bath of almost any concentration, which at the same time is slightly acid in reaction and contains chlorine in the form of nickel chloride, to give good anode corrosion. One of the secrets of the successful operation of baths which are employed for nickeling zinc is the use of the proper current density, which is somewhat higher than that required with ordinary metals, particularly at the beginning. In other words, it is necessary to *strike* the parts, so that a thin deposit of nickel can be quickly given, which then will prevent any action between the zinc and the solution, with the resultant formation of the black, pulverulent deposit. The initial current density which must be used varies somewhat with the concentration of the nickel in the bath, but it has been found that the alkali salts of certain organic acids, citrates, malates and tartrates make it possible to use lower densities at the beginning of the operation.

A bath of the following composition has been recommended for plating zinc directly: Nickel sulphate, 32 ounces; nickel chloride, 2 ounces; boric acid, 4 ounces; sodium citrate, 23 ounces, and water, one gallon. It is claimed that this bath works satisfactorily at current densities ranging from about 4.6 amperes per square foot to 65 amperes per square foot. It is advisable to use only pure electrolytic anodes with this bath.

Beehive Coke Production

The production of beehive coke in 1916 was the greatest ever recorded in the United States, and the average value per ton was higher than in any previous year. The official figures for 1916, published by the United States geological survey, show that 35,464,224 tons of beehive coke, valued at $95,468,127, were produced last year. The output in 1916 represented an increase over 1915 of 7,955,969 tons, or 29 per cent, in quantity, and $38,522,584, or nearly 68 per cent, in value. The average value per ton of the coal used in making beehive coke in 1916 was $1.26, an increase of 21 cents, or 20 per cent, and the average value of the coke was $2.69, an increase of 62 cents, or 30 per cent.

The number of active beehive ovens in 1916 was 65,605, as against 48,985 in 1915, an increase of 16,620. The number of idle ovens was 25,976, as against 44,125 in 1915. Abandoned ovens numbered 2265, of which nearly 1800 were in Pennsylvania and West Virginia. No new establishment and but 104 new beehive ovens at old works were reported to be under construction at the end of 1916, a low record compared with recent years, especially in view of the high prices and steady demand for coke throughout the year. The coke producers evidently recognize the fact that the day of the beehive oven is passing, and that after the present abnormal condition is over most coke will be made in by-product ovens.

The Sand Mixing Machine Co., 52 Vanderbilt avenue, New York, recently received orders for auto sand cutters from the following concerns: Wehr Steel Co. and the Falk Co., Milwaukee, Akron Steel Casting Co., Akron, O.; United States Malleable Iron Co., Toledo, O.; George V. Cresson & Co., Philadelphia, Interstate Foundry Co. and Ferro Foundry & Machine Co., Cleveland.

Early Types of American Heating Stoves

By W J Keep

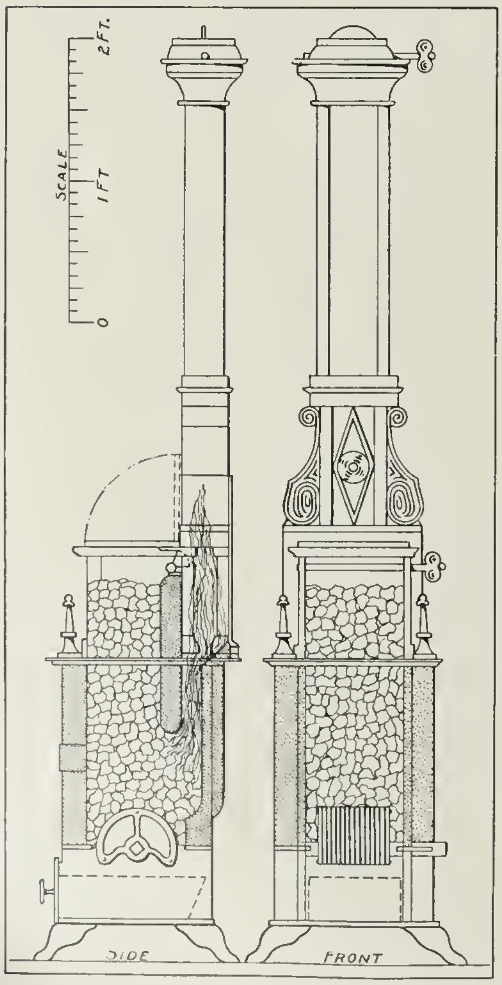


FIG. 1—SIDE AND FRONT SECTIONS OF THE BASE BURNER PATENTED BY DR. NOTT IN 1828

PROBABLY the first stove made in this country is illustrated in Spark's edition of the works of Dr. Benjamin Franklin (vol. 6, page 34) and was called the Pennsylvania fireplace. This was the first Franklin stove, having been made at Warwick Furnace, Pa., about 1742.

The first patent for a stove granted in this country was issued to Robert Heterick on June 11, 1793, for "A Cast Iron Stove". The second stove patent was issued May 4, 1802, to Henry Abbott, for casting "Close Stoves". Records are not available containing descriptions of these stoves nor the addresses of the inventors. The third patent for a stove was granted to Allan Pollock, of Boston, on June 11, 1807. The same stove was patented in England and the sketch of this Pollock stove, shown in Fig. 2, was taken from an engraving in the "Repertory of Arts", second series, vol. 12, page 170.

Anthracite coal was discovered in surface outcroppings at Mauch Chunk, Pa., in 1793, but as it was found to be almost impossible to burn it, less than 365 tons were mined before 1820. About that time the Lehigh Coal Mine Co. sent a small quantity of this American coal to Dr. Nott, president of Union College, Schenectady, N. Y., who in-

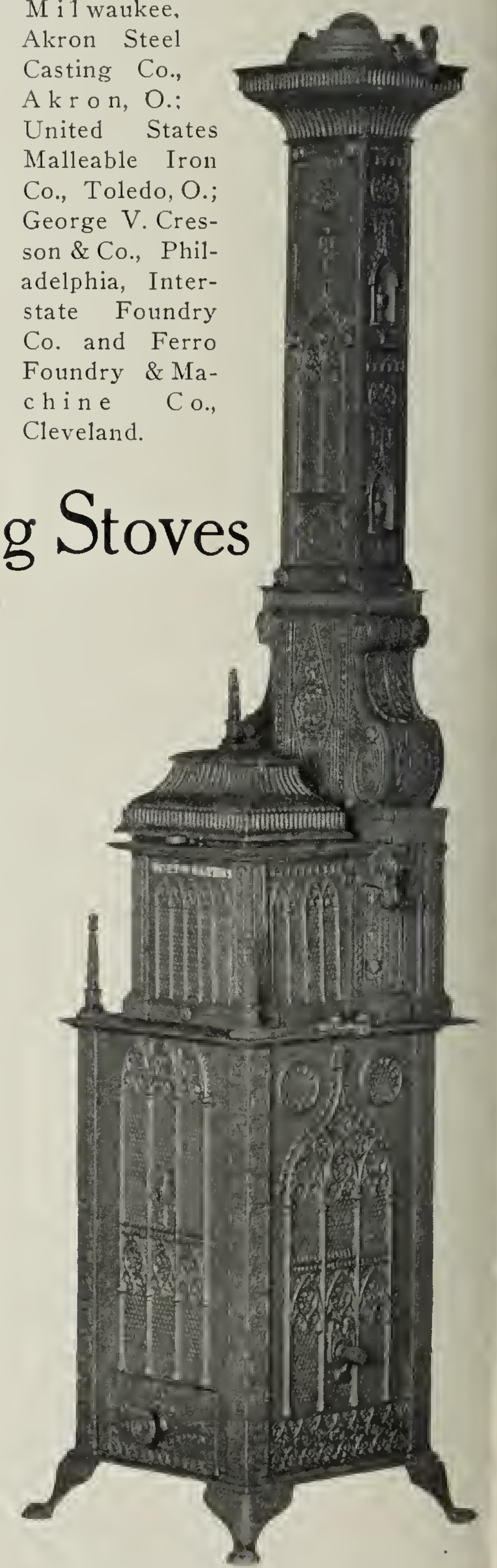


FIG. 2—DR. NOTT'S BASE BURNING STOVE IN THE POSSESSION OF W. J. KEEP

vented a wood-burning stove. He was requested to build a stove in which this coal could be burned. After experimenting for five years he applied for several patents for "The Evolution of Heat" from this coal, in 1826 and 1827. On March 26, 1828, he applied for patents on the stove illustrated in Figs. 1 and 2.

The coal was broken in small pieces and filled the brick-lined chamber. It was burned on a *saracenic grate,* as Dr. Nott termed it, which, when rolled over, formed a basket into which fell the clinkers and slate. When the grate was rolled back again the clinkers and slate fell out into an ash pan, leaving a bright fire in the grate. The coal burned at the base of the body of the charge and the products of combustion passed through a small brick-lined flue into an iron radiator above. These tall radiators were popular for many years. The castings for this stove were ¼-inch thick in the ornamented parts. This stove was presented to the writer in 1866 and constituted a part of the exhibit of the Michigan Stove Co. at the World's Fair in Chicago, in 1893.

The patent for which Dr. Nott applied in 1828 was not issued until Sept. 17, 1832. On May 30, 1832, Jordon L. Mott, of New York City, was granted a patent for a base burning stove which embodied many of the principles of the modern base burner. The stove designed by Jordan L. Mott and patented in 1832, is shown in Fig. 4. This stove had a self-feeding magazine. The surface of the burning coal, after it left the magazine, sloped to the side of the firepot. A large combustion chamber was provided above the burning coal. In 1849 a patent was granted to Thomas Walker, in England, in which the combustion chamber and sloping coal extended all around a cylindrical magazine.

Mr. Mott always contended that he was the first to develop the modern base burner, which undoubtedly is true, but Dr. Nott, four years earlier burned coal at the base of a chamber filled with coal. Prior to 1834, castings for stoves were made at a blast furnace near Philadelphia, the iron as it flowed from the furnace having been poured into molds. At about that date, however, Jordon L. Mott, in New York; Joel Rathbone, in Albany, and James Wager, in Troy, built foundries for the exclusive manufacture of stoves, the iron having been melted in cupolas. The foregoing notes are taken from the manuscript entitled "History of American Stoves", by W. J. Keep.

A 12-page booklet has been issued by the William Powell Co., Cincinnati, which illustrates and describes the automatic injector which it manufactures. A table of sizes and a price list also are included. The method of connecting the injector is illustrated and suggestions for its installation are given.

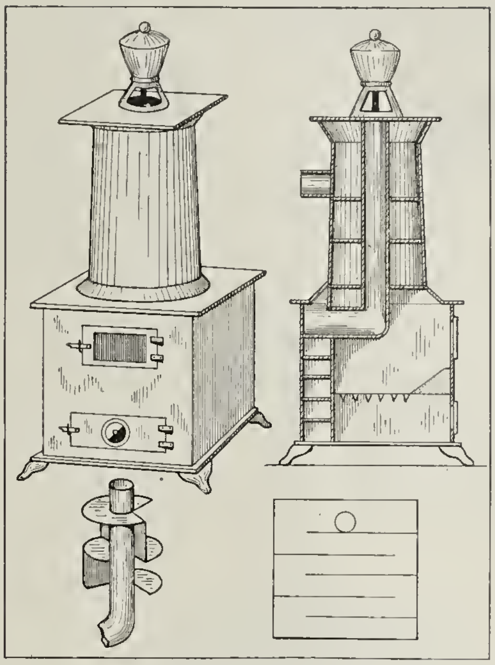


FIG. 3—STOVE PATENTED BY ALLAN POLLOCK IN 1807

Production of Semisteel Shells

By David McLain

The article published on page 253 of the July issue of THE FOUNDRY entitled, "What the War Has in Store for the Foundry Trade", is very interesting, particularly the recommendation that a commission be sent to France to investigate the process of making cast shells. However, the writer does not believe that it is necessary to send a commission to France for this purpose.

The iron ore in France is high in phosphorus and the pig iron made therefrom contains 2 per cent and more of this element. High phosphorus pig iron melted in the cupola with steel scrap is unfit for semisteel. Owing to the high phosphorus in the pig iron, the basic process of making steel in France is compulsory, both in open-hearth and converter practice and, therefore, is highly developed. Assuming that one-third, by weight, of liquid converter metal is added to the cupola iron, which may carry 0.02 per cent of phosphorus in the ladle of cupola metal of 50 steel and 50 iron, then the phosphorus in the final mixture will be approximately 0.60 per cent, which is within fair limits for light sections.

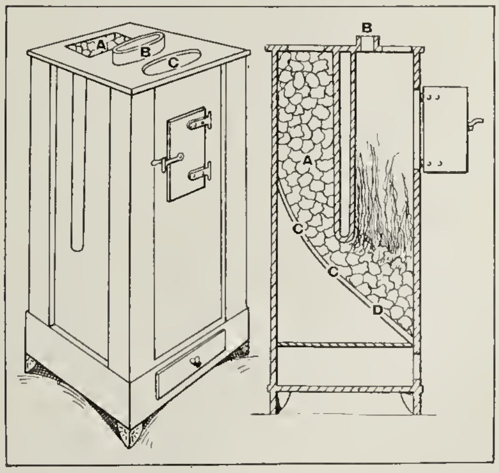


FIG. 4—BASE BURNING STOVE PATENTED BY JORDON L. MOTT IN 1832

However, it may be possible that "the bessemer converter metal, low in phosphorus" referred to, is not pig metal, but blown liquid metal, and this feat can be duplicated anywhere in the south, by installing basic converters and using high phosphorus pig iron. Again it may be possible that the French are using hematite pig, which is now selling at $35 per ton in England and is similar to our low phosphorus pig iron, selling at $80 to $100 in this country. However, if the French are able to import pig iron from England, which I am inclined to doubt, why should they add one-third converted metal to the cupola metal? However, 40 per cent of hematite pig iron, 30 per cent of French pig iron and 30 per cent of steel, melted in the cupola will produce a hotter metal, which is more homogeneous and of lower phosphorus content and can be made at a lower cost.

In Germany, semisteel shells have been made for many years, and in December, 1914, in an address delivered before the Detroit Foundrymen's association the writer discussed the employment of semisteel for projectiles and shells. A few of my auditors did not agree with me, yet I maintained that semisteel would be used extensively before the war was in progress many months.

Semisteel shells have been made in this country for some time and we will be glad to place our services at the disposal of our munitions experts to prove to them that semisteel is a satisfactory metal for this purpose.

In the government specifications covering projectiles, the metal is referred to as "cast iron of 30,000 pounds tensile strength or over", but we know of no cast iron test bars that have met these requirements and, therefore, from 30 to 40 per cent of steel scrap is added to the mixture with the result that a tensile strength of 32,000 pounds per square inch and more is obtained. For this reason we term this metal semisteel.

In the place of babbitt metals one inventor proposes to use mixtures of metallic sulphides in widely varying proportions. He considers that the sulphides of copper, lead, tin and antimony make good babbitt substitutes. Metallic sodium is used to improve their casting properties.

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Contents

PAGE
Casting Chilled Car Wheels in a Canadian Foundry........... 297
The Influence of Design on the Cost of Patterns............ 301
Control of Cooling Metal in Cast Iron Work.................. 302
Use of Chills in Malleable Iron Practice.................... 303
Heading, Gating and Chilling Steel Castings................. 304
Varying Strength in Different Parts of a Large Casting...... 305
Repairing Cracks in Steel Castings Electrically............. 306
New Cleveland Stove Foundry for Maximum Output........... 307
Preventing Cupola Bridging 310
Institute of Metals Prepares a Great Program................ 311
A Study of the Steel Foundry Sand Problem................. 312
Chilling Mine Car Wheels.................................. 315
The Safe Handling of Crucibles in the Foundry............. 316
Navy Revises Steel Casting Specifications.................. 318
How to Prevent Dull Iron................................... 318
Modern Methods of Gating Malleable Castings.............. 319
Chilled Iron Balls 321
Some Test Bar Suggestions For Nonferrous Metal............ 322
Problems of the Brass Founder.............................. 326
Core Sand for Brass... 326
Mixture for White Metal Patterns............................ 326
Plaster of Paris in the Brass Foundry...................... 326
Strong Aluminum Alloys 327
Castings Subjected to Water Pressure....................... 327
How to Prevent Pin Holes in Brass Castings................ 327
Remedying Brittle Bushings and Gear Blanks................ 327
Mixture for Oxyacetylene Torch Castings.................... 327
Progress in the Manufacture of Steel Castings.............. 328
Intelligent Use of Nickel-Plating Solutions................ 333
Early Types of American Heating Stoves.................... 336
Production of Semi-Steel Shells............................ 337
War—The Industrial Crucible 338
Trade Outlook 338
Slag Tests for Silica Brick................................. 340
What the Foundries are Doing.............................. 341
New Trade Publications 342

War—The Industrial Crucible

IT IS generally conceded that much of the progress made in the development of an industry results from the dissemination of knowledge and experience among manufacturers and engineers. Up to within a few years ago the interchange of ideas was largely confined to the borders of each nation, and there was a noticeable tendency in many instances for the leading powers to closely guard their inventions and developments for local benefit. Largely on account of this practice, the engineering talent of each nation soon evidenced decided proficiency in specialized lines of endeavor. In Germany an enviable reputation for efficiency and execution of detail was attained. England, though slow to grasp the principles of systematized management, acquired a unique faculty for thoroughly investigating the intricacies of metallurgy. American engineers developed the ability to organize industry for producing large quantities of standardized articles.

The war already has shown signs of altering this standard of industrial development. Martial necessity is enlisting the aid of American ingenuity in solving the problems of France, England and Russia, and the engineers of these European nations are lending their experience to manufacturers in the United States. Although the present exchange of knowledge is chiefly restricted to matters pertaining to military problems, there is nothing to indicate that the welcome innovation will not spread to other lines of pursuit. Perhaps we are warranted in anticipating the time when the spread of technical information will be international.

Trade Outlook

ALTHOUGH the tendency to attain higher levels was not as marked in July as in the preceding months, the price of pig iron continues its march toward the $75 figure, which many forecasters have set for the end of the present year. The railroad situation continues to hold the price of foundry coke at the high mark established several months ago. Bessemer iron is quoted at $57 to $58, and basic at $52 to $55, valley. No. 2 foundry pig iron is listed in the leading trade centers as follows: Pittsburgh, $55.95; Chicago, $55; Cleveland, $55 to $56; Buffalo, $52 to $54; Birmingham, $47 to $50; and Philadelphia, $52 to $53.50. Connellsville foundry coke sells at $13.50 to $14.

James Brice once said: "There is no influence in any community more potent and powerful for the accomplishment of good, than that of business men unselfishly banded together for the purpose of promoting the general welfare of the entire citizenship." In the foundry field no organization comes nearer to wielding this influence for good than the American Foundrymen's association. At no time in history has there been a greater need for this influence than the present. Therefore, foundrymen who have the welfare of the industry at heart will encourage, support and attend the annual meeting at Boston.

Death of P. L. Simpson

Peter Liston Simpson, manager of the National Engineering Co., died July 11, at his home in Chicago. Mr. Simpson was born in Boness, Scotland, and served his apprenticeship in Bathgate Foundry, Bathgate, Scotland. He moved to Toronto, Canada, in 1870, where he married Janet L. Teasdale of Airdrie, Scotland. After working in several foundries in Toronto, he moved to Cleveland, where he finally became owner of a gray iron foundry. While he was superintendent of Youngslove Massey Co. in Cleveland, he made an engine cylinder which is thought to have been the first steel casting produced west of the Ohio river. In 1881 he moved to Minneapolis, where he was foundry superintendent for the North Star Iron Works. Later he embarked in the clay-working machinery business, inventing a dry press brick machine, which became widely and favorably known. He also designed and built a gear-molding machine which attracted considerable attention among foundrymen. In 1889 he moved to Chicago, where he lived until his death, except for two years, 1903 and 1904, when he was located in Willoughby, O. In recent years he designed a foundry mixer, a core reducer and a screen separator, all of which bear the name of the inventor and are manufactured and sold by the National Engineering Co., a company which Mr. Simpson organized and developed. Mr. Simpson was a member of the Chicago Foundrymen's club, American Foundrymen's association, and was reputed an expert in foundry management. He leaves his wife, a daughter and two sons, one of whom, H. S. Simpson, has taken charge of the National Engineering Co.

Personals

George M. Deems has been appointed manager of the Elmwood Castings Co., Cincinnati.

Oliver C. Brace has resigned as sales manager of the Farrell-Cheek Steel Foundry Co., Sandusky, O., to devote his time to the Sandusky Nut Co., of which he is president.

F. A. Beebe, formerly director of foundries of Sears-Roebuck & Co., Chicago, has been appointed foundry superintendent of the Haskell & Barker Car Co., Michigan City, Ind.

W. H. Quirk has been appointed manager of the electrical supply house of the Western Electric Co., Cincinnati. W. L. Sioussat will succeed Mr. Quirk as store manager at Cleveland.

G. W. Guilderman, who resigned as superintendent of the foundry of the Advance-Rumley Thresher Co., La Porte, Ind., several years ago, has returned and resumed his former duties.

G. C. Jones has resigned as metallurgical engineer of the Whiting Foundry Equipment Co., Harvey, Ill., to accept a position with the Huntington Steel Foundry Co., Huntington, Ind.

C. C. Peterson, formerly affiliated with the Bridgeport Malleable Iron Co., and the Rhode Island Malleable Iron Co., has been appointed works manager of the Standard Malleable Iron Co., Muskegon, Mich.

R. A. Bull has resigned as vice president and general manager of the Chicago Steel Foundry Co., Chicago, to accept the position of vice president and general manager of the Duquesne Steel Foundry Co., Coraopolis, Pa.

PETER LISTON SIMPSON

J. A. Flood, formerly connected with the Venango Mfg. Co., Franklin, Pa., now is general manager of the Producers Supply Co., that city, which recently completed a new gray iron foundry, having a daily capacity of 25 tons.

L. P. Orr, Cleveland representative of the Allis-Chalmers Mfg. Co., Milwaukee, assumed the position of sales manager of the Cleveland Electric Motor Co., on May 1. Mr. Orr has had a wide experience in the manufacture and sale of electrical equipment.

S. Carroll, for many years affiliated with the National Transit Co., Oil City, Pa., in the capacity of foundry superintendent, and later with the Taylor-Wilson Mfg. Co., McKees Rocks, Pa., has been appointed foundry superintendent of George B. Limbert & Co., East Chicago, Ill.

W. R. Day, general manager of the Hart-Parr Co., Charles City, Iowa., has been elected vice president to succeed A. E. Ellis, resigned. Donald D. Davis has been elected secretary to fill the vacancy existing by the appointment of C. H. Parr to he position of chief engineer.

Harry H. Barclay, manager of the Beryk Co., Cleveland, manufacturer of foundry vibrators, has been elected president and general manager to succeed Charles H. Olds, resigned. M. W. Barclay was elected vice president, and E. B. Carbaugh, secretary and treasurer, succeeding C. H. Keith, resigned.

M. Cochran Armour has withdrawn from the firm of Rogers, Brown & Co., Cincinnati. For a period of 27 years he was a member of this partnership, having been admitted in 1890. Mr. Armour represented the Rogers, Brown interests in the Chicago district for more than a quarter of a century, and he was widely known as a producer and distributor of pig iron.

Oil For Cores

Through a typographical error in the advertisement of the Werner G. Smith Co., Cleveland, in the July issue of THE FOUNDRY, it was stated that "Linoil binds more acid, stronger cores, ..." The sentence in question should have read, "Linoil binds more sand, makes stronger cores, ... ".

The Damascus Bronze Co., Pittsburgh, is building an extension, 60 x 100 feet, to the molding department of its foundry. A smaller building, 20 x 100 feet, is under erection. Additions are being erected under the supervision of Prach & Perrine, Pittsburgh, architects and engineers.

The Ross Power Equipment Co., Merchants Bank building, has been appointed Indianapolis representative of the Lincoln Electric Co., Cleveland, manufacturer of alternating and direct-current motors and generators, electric arc welding plants and automobile battery charging apparatus.

Doughten & Son, 41 South Fifteenth street, Philadelphia, have leased the mica schist and silica rock quarries of the William Penn Silica Works, Conshohocken, Pa. Mining operations will be commenced immediately.

Slag Test for Refractory Brick in Steel Industry

Methods of Determining Effect of Fineness of Slag on Penetration —Drilled-Pocket Method Gives More Uniform Results Than Immersion

By C E Nesbitt and M L Bell

EARLY in the study of the physical properties of refractory material in the iron and steel industry, the necessity for a slag test which would give information as to the relative resistance of refractory brick to various slags and fluxes became apparent. To be of use in specifications it was evident that such a test must be rapid, easily performed, and applicable to any kind of brick or slag, and should as far as possible approach conditions similar to those under which the brick is to be used.

As a basis for a test it was decided to place the brick in contact with a certain slag and apply heat until the slag was thoroughly melted. When cold the amount of penetration was observed. In the preliminary work the piling of the slag on the brick was tried, but the results were negative, as the slag ran off the brick as soon as melted, producing no marked penetration. Kaolin rings were tried in hope of confining the slag, but these failed to accomplish their purpose. Pockets were next cut in the brick by chipping. This proved to be successful in confining the slag but the chipping was too slow and it was difficult to secure uniform cavities. Drilling by means of a press was next resorted to, and uniform pockets as near as the nature of brick material would permit were drilled. The bricks were then heated to testing temperature and a known quantity of slag was placed in the drilled cavities. After the bricks had become cold they were broken through the slag cavity and examined. Visual examination proved of small value, as results could not be accurately compared; hence it was found necessary to devise some means by which the amount of penetration could be measured. This was accomplished by sawing the brick so that one of the sawed faces accurately bisected the center of the original cavity, and the area of slag penetration thus exposed was then measured by means of an ordinary planimeter.

To standardize the method it became necessary to determine whether the fineness of the slag, the time to which the slag was exposed to the brick, and the amount of slag used in the test had any effect upon the amount of penetration.

Determining Effect of Fineness

To determine the effect of fineness of the slag on the amount of penetration, blast furnace and heating furnace slags were selected as representative of the iron and steel industry. Each was ground and separated into two sizes, coarse and fine. The coarse material was that which passed a 40-mesh and remained on a 60-mesh sieve, while the fine was represented by that which passed through a 100-mesh sieve. The slag test was then run in the usual manner on standard hearth and bosh blast furnace brick. The average results were as follows:

	Penetration, square inch.
Blast-furnace Slag—	
40 to 60-mesh	1.54
100-mesh	1.67
Heating-furnace slag—	
40 to 60-mesh	1.77
100-mesh	1.72

From the above results it is apparent that the degree of fineness of the slag does not affect penetration.

To determine whether the time to which the slag was exposed to the brick, and also whether the amount of slag used in the test affected the penetration, a series of slag tests were run, in which the slag was exposed to the brick at testing temperature for two, four and six hours, with the quantity of slag varying from 35 to 140 grams. The result of slag penetration are given in Table I.

In Table I it is shown that the amount of penetration is not increased by keeping the brick in contact with the slag for a longer period than two hours. Preliminary work had shown that one hour would in most cases give complete penetration, so that the adoption of two hours was considered sufficient to guarantee full action of the slag.

It will also be noted that there are two variables, namely, the amount of slag used and the area exposed to slag action. To make the average results comparable these variables must be eliminated. This was accomplished by reducing the area exposed to slag action to a unit figure by dividing the area of the standard cavity (5.94 square inches) into each of the other areas (columns 3, 4 and 5 in Table I). The ratio figures thus obtained were divided into the average slag penetration and the results (slag penetration divided by ratio) made comparable. These figures prove that increasing the amount of slag does not affect the slag penetration, when reduced to a unit of area exposed to slag action. The variation in the results are within checking limits and the difference due to the variation in the bricks themselves.

The question of the advisability of performing a slag test in a drilled pocket as compared to immersing the brick in molten slag was next studied. Bricks from the same shipment were tested, one-half of them by the drilled-

Table I

Effect of Fineness on Amount of Penetration

	Penetration for—Grams of Slag used, square inch.			
Time of Exposure, hours.	35	70	105	140
2	0.49	0.58	....	....
2	0.51	....	0.79	....
2	0.45	....	....	0.79
4	0.51	0.58	....	....
4	0.43	....	0.78	....
4	0.43	....	....	0.83
6	0.46	0.52	....	....
6	0.44	....	0.70	....
6	0.52	....	....	0.89
Average	0.45	0.56	0.76	0.84
Area exposed to slag action, square inch	5.94	7.97	8.57	9.44
Ratio of exposed area to standard cavity	1.00	1.34	1.44	1.59
Average slag penetration divided by ratio	0.45	0.42	0.53	0.53

Presented at the annual meeting of the American Society for Testing Materials, held at Atlantic City, June 26 to 29.

ocket method in the usual way, while he others were placed on edge in a efractory tray or shallow box, in vhich slag was placed to a depth of ½ inches. All were heated at a uni- orm rate of 1350 degrees Cent., and eld for one hour. After cooling the ricks were cut at right angles to heir length into two or three sec- ions, the cuts being about 1 inch part. The drilled-pocket samples were ut in the usual way, a second cut eing then made at right angles to he first. The areas of slag penetra- ion thus exposed were measured vith a planimeter; also, the linear nches of slag contact on the surface of the brick were measured. Heating urnace slag was used in this test. Table II gives the results of these ests.

Table II
Comparison of Drilled-Pocket and Immersion Methods

Sample.	Area No.	Immersion Method. Slag penetration, square inch.	Immersion Method. Slag contact of brick, linear inch.	Immersion Method. Slag penetration per linear inch of contact.	Drilled-Pocket Method. Slag penetration, square inch.	Drilled-Pocket Method. Slag contact of brick, linear inch.	Drilled-Pocket Method. Slag penetration per linear inch of contact.
A	1	5.50	7.0	0.78	1.67	3.5	0.48
	2	1.68	7.0	0.24	1.48	3.5	0.42
	3	2.50	7.0	0.36	....	..	....
B	1	4.96	8.5	0.58	1.10	3.5	0.31
	2	4.82	8.5	0.55	1.06	3.5	0.30
C	1	0.91	10.0	0.09	0.88	3.5	0.25
	2	0.57	10.0	0.10	0.71	3.5	0.20

From the results it is evident that greater uniformity of results is obtained by use of the drilled pocket than by immersion. The drilling of pockets to contain the slag is also preferable to the use of large trays to contain the slag, because of economy of space in the furnace.

The drilled pocket method as at present adopted has several points which recommend it as a standard method. It is very flexible, as cavities, slags, temperature and the amount of slag can be easily changed to correspond to the service conditions under which the bricks are to be used. It is rapid, easily performed, and results are expressed by a definite numerical quantity.

When clay bricks for blast furnace or similar uses are to be tested, blast furnace and heating furnace slags are used. Silica bricks for open-hearth use are tested with open-hearth and heating furnace slags.

G. J. McFadden, formerly connected with the Chicago Pneumatic Tool Co., Chicago, now is general manager of the Nagle-Corliss Engine Works, Erie, Pa., manufacturer of gas and steam engines, air compressors and vacuum pumps.

Samuel L. Nicholson, who has been sales manager of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., since 1909, has been appointed assistant to the vice president of this company.

Herbert A. Johnson has resigned as superintendent of the North & Judd Mfg. Co., New Britain, Conn., to accept the chairmanship of the hardware equipment committee of the council of national defense.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Starr Foundry Co., Covington, Ky., has increased its capital from $20,000 to $40,000.

The Richmond Foundry & Mfg. Co., Richmond, Va., has increased its capital from $100,000 to $400,000.

The Taylor Coupler & Castings Co., Toledo, O., has completed the erection of a foundry building, 60 x 126 feet.

The Fulton Foundry & Machine Co., Cleveland, recently has been organized with $10,000 capital by Harold T. Clark and others.

The American Foundry Co., Elizabeth, N. J., has been incorporated with $125,000 capital by Morris Jigger, Otto Froebel and others.

The Globe Foundry & Mfg. Co., Berkeley, Cal., has been incorporated with $50,000 capital by A. J. Tucker and R. S. and H. R. Elliott.

The Leetsdale Foundry & Mfg. Co., Leetsdale, Pa., has been incorporated with $30,000 capital to engage in the manufacture of gray iron castings.

The National Castings Co., Carlisle, Pa., has been organized with $50,000 capital by Jacob R. Foreman, A. G. Vashoar, R. Morrett and Walter R. Sohn.

The machine shop and foundry of Thomas Carlin's Sons, Pittsburgh, were sold at public auction to the Modern Machinery Exchange and the Manhattan Machinery Exchange, New York, for $120,100.

The Bloomfield Foundry Co., Bloomfield, N. J., manufacturer of brass, aluminum and nickel castings, has completed an extension to its plant, 65 x 125 feet.

The Cotter Brass Foundry Co., Pittsburgh, has been incorporated with $10,000 capital to engage in the operation of a plant for the manufacture of brass castings.

The Rhode Island Foundry & Machine Co., Providence, R. I., has been incorporated with $100,000 capital by Henry S. Chaffee, Dwight R. Bartlett and Samuel Raynor.

The East Chicago Foundry Co., East Chicago, Ind., has been incorporated with $30,000 capital by Harry C. Stuart, Henry S. Evans and P. S. and William F. Graver.

The Chrisman Foundry Co., Westover, W. Va., has been incorporated with $100,000 capital by A. H. McBee, Frank Fox and E. F. Beall, all of Morgantown, W. Va.

The Modern Foundry Co., Cincinnati, is building an addition to its plant, 80 x 200 feet, part of which will be devoted to pattern storage, and in the other section new core ovens will be installed.

The Portage Foundry Co., Akron, O., has been organized with $150,000 capital to engage in the operation of a gray iron foundry. S. W. Harris, W. E. Wilson, G. F. Hobach, C. G. Wise and H. E. Andress are the incorporators.

The Sweetser & Bainbridge Metal Alloy Co., Albany, N. Y., has been incorporated with $10,000 capital to engage in the manufacture of metal alloys. The incorporators are S. P. Sweetser, E. F. Bainbridge and H. E. Batcheller.

Benjamin E. Jarvis, Newark, N. J., who has operated a large jobbing pattern shop, has incorporated under the name of Benjamin E. Jarvis, Inc., with a capital of $50,000. In addition to Mr. Jarvis, the incorporators include J. T. Clark and L. C. Lotz.

The American Tank & Valve Co. has removed from Indianapolis to its new plant at Fairmont, W. Va. The works consist of a gray iron and brass foundry, 60 x 160 feet, and a machine shop, 90 x 180 feet. Provisions have been made for an extension to the machine shop, 90 x 200 feet.

The Columbian Brass Foundry, 30 Church street, New York, and the Columbian Bronze Corp., Freeport, L. I., have been consolidated under the name of the latter corporation with a capital of $450,000. The Columbian Bronze Corp. operates a plant in Freeport for the manufacture of brass fittings for motor boats and similar specialties.

The Champion Foundry & Machine Co., Chicago, which recently changed its name from the Champion Foundry Machine Co., has established a gray iron foundry at Aurora, Ill. The plant is equipped with two cupolas and recently was placed in operation. J. T. Magnuson is president and H. O. Magnuson is secretary and treasurer.

The Lewisburg Stove Co. is the firm name of the corporation which has acquired the plant of the Lewisburg Foundry Co., Lewisburg, Tenn. The patterns of cook stoves and heaters, cast and steel ranges, as well as the range machinery, will be sold. This company will manufacture heaters. W. T. Archer is president and C. C. Stoll is secretary and treasurer.

The Brady Foundry Co. has completed three buildings of its new plant, which is one of the largest foundries in Chicago, producing general heavy gray iron castings. The new buildings are 140 x 300, 90 x 220 and 90 x 200 feet, respectively. Although some heats are being taken off at present, the new foundry will not be operated to capacity until the middle of August.

New Construction

C. A. Goldsmith, Newark, N. J., will erect an addition to his foundry.

The Hoods. Mfg. Co., Seattle, Wash., will erect a foundry, 70 x 100 feet.

The Lima Steel Casting Co., Lima, O., will erect an addition to its plant, 50 x 200 feet.

The Belding Foundry Co., Belding, Mich., is building extensive additions to its plant.

The Bedford Foundry & Machine Co., Bedford, Ind., will build an addition, 50 x 80 feet.

The Bristol Brass Co., Bristol, Conn., is building an addition to its plant, 50 x 120 feet.

W. N. Neiman and L. K. Saul, Hamburg, Pa., will build a foundry addition, 50 x 200 feet.

Beatty Bros., Ltd., Fergus, Ont., Canada, contemplate the erection of a malleable iron foundry.

The Lunkenheimer Co., Cincinnati, contemplates the erection of additions to its brass foundry.

The Howard Stove Co., Beaver Falls, Pa., will build an extension to its foundry at a cost of $12,000.

The Glamorgan Pipe & Foundry Co., Lynchburg, Va., will erect an extension to its plant, 40 x 80 feet.

The Dayton Malleable Iron Co., Dayton, O., is building an addition to its plant at Ironton, O., 110 x 160 feet.

The Harrison Steel Castings Co. is commencing the erection of a steel castings plant at Murphysboro, Ill.

The plant of the General Foundry & Mfg. Co., Youngstown, O., recently destroyed by fire, will be rebuilt.

The Eagle Brass Foundry, Seattle, Wash., will erect a foundry, 90 x 105 feet, and a pattern shop, 25 x 29 feet.

The Marshall Castings Co., Marshall, Mich., of which M. Campbell is manager, will erect a foundry at a cost of $25,000.

The Bell City Mfg. Co., Racine, Wis., manufacturer of agricultural implements, will erect a foundry addition, 50 x 120 feet.

The General Electric Co., Schenectady, N. Y., is erecting a foundry building, 80 x 340 feet, four stories high, at East Boston, Mass.

The Gray Foundry, Inc., Poultney, Vt., manufacturer of gray iron castings, recently completed a 60-foot addition to its shop.

The Monighan Foundry Co., Chicago, will build an addition to its plant, 92 x 96 feet. A. P. Webber, 10 South LaSalle street, is architect.

The Killian-Strait Tractor Co., Appleton, Wis., will build a foundry, 50 x 75 feet. This company manufactures gas and oil tractors.

A vocational school will be built by the board of education, Newark, N. J., at a cost of $206,700, which will include a foundry and pattern shop.

The Hamilton Foundry & Machine Co., Hamilton, O., contemplates the erection of an addition to its shop at a cost of approximately $5000.

The Bunting Brass & Bronze Co., Toledo, O., manufacturer of brass and bronze castings, will build an addition to its plant at a cost of approximately $14,000.

The Lake Torpedo Boat Co., Bridgeport, Conn., has awarded contracts for the erection of two foundry buildings, respectively 80 x 100 feet and 20 x 30 feet.

S. Birkenstein & Sons, Chicago, manufacturers of metal alloys, contemplate the erection of a warehouse on a site recently purchased on Hawthorne, avenue.

The Mayer Bros. Co., Mankato, Minn., is building an extension to its foundry, 36 x 116 feet. The machine shop also is being increased in size by an addition, 40 x 80 feet.

A steel casting plant to be equipped with electric furnaces will be added to the truck division of the General Motors Co., Pontiac, Mich. The foundry was designed and the construction is being supervised by H. H. Allen, General Motors Co., Detroit.

At the League Island navy yard, Philadelphia, the casting producing capacity will be increased by the erection of a foundry, 180 x 648 feet, at an estimated cost of $532,968.

The Flint Foundry Co., Flint, Mich., which specializes in the manufacture of automobile castings, contemplates the erection of a 50-ton casting shop. F. L. Carpenter is manager.

The Worcester Foundry Co., Worcester, Mass., will erect an addition to its plant, 52 x 198 feet. The Mill Engineering & Construction Co., Waterbury, Conn., has the contract for the erection of the building.

The Independent Foundry Co., West Allis, Wis., recently incorporated, will build a gray iron shop, 85 x 100 feet. The company was organized by several foremen and molders of gray iron foundries in the Milwaukee district.

The Glover Machine Works, Atlanta, Ga., will install an electric melting and refining furnace, to be furnished by the John A. Crowley Co., Detroit. The foundry building, which already has been erected, will be commanded by a 40-foot crane of 15 tons capacity.

The Hesse-Martin Iron Works, Portland, Ore., will erect a foundry, 80 x 100 feet, and a machine shop of the same size. In addition blacksmith and structural shops also will constitute the plant. A specialty will be made of auxiliary machinery for ships, including winches, anchors, steering engines and gears, propellors. etc.

NEW TRADE PUBLICATIONS

COMPRESSORS AND VACUUM PUMPS.—The Ingersoll-Rand Co., New York, in a 32-page bulletin, illustrates and describes compressors and vacuum pumps for the extraction of gasoline from natural gas. Another bulletin is devoted to rock drills, which contains a number of field views illustrating their use.

FOUNDRY AND STEEL WORKS EQUIPMENT.—A 60-page catalog, issued by the Biehl Iron Works, Inc., Reading, Pa., illustrates and describes the extensive line of coal and ore trucks and buckets of various types manufactured by this company. Many types of industrial cars are also shown, as well as skip hoists for blast furnace work. For foundry work a large core oven car is illustrated, as well as flat top trucks, charging barrows, etc.

PLATERS' EQUIPMENT AND SUPPLIES.—An exceedingly comprehensive catalog containing 260 pages has been issued by the Canadian Hanson & Van Winkle Co., Ltd., Toronto, Ont., which is devoted to electro-plating and polishing supplies, including nickel, chemicals, lacquers, dynamos, polishers' and buffers' supplies, grinding machinery, etc. This catalog will prove of value to all operators of plating rooms. A smaller catalog containing 104 pages also has been issued by this company which contains many valuable suggestions for equipping electro-plating plants.

BORONIC METAL ALLOYS.—A 16-page pamphlet has been issued by the American Boron Products Co., Inc., Reading, Pa., which describes boronic copper and boronic metal alloys. These boronic products are deoxidizers for nonferrous and ferrous metals. Boronic copper consists of electrolytic copper impregnated with boronic gases, occluded by the copper. The copper thus treated becomes a flux, and when the gas of boronic copper is liberated in the re-melt it serves the purpose of deoxidizing, cleansing, solidifying and alloying. It is claimed that the gases in their efforts to cleanse the metals from oxides cause a stirring or mixing of the entire metallic mass, creating a molecular migration and thereby effecting an alloy or mixtures, absolutely homogeneous and uniform; 23 boronic specifics are made for alloying and deoxidizing different mixtures, which include boronic aluminum, boronic nickel, boronic copper, etc.

CRANES.—An exceedingly comprehensive 80-page catalog devoted to its extensive line of cranes has been issued by the Whiting Foundry Equipment Co., Harvey, Ill. This company has had more than 25 years' experience in building and operating cranes, and their conveying appliances are offered to the trade for all classes of service, from the simple 1-ton handpower bridge to the heavy electric crane for handling locomotives. In addition to the numerous illustrations of the various types of cranes built, a large number of service views are shown of cranes in operation in railroad shops, foundries, stone quarries, yard service, power plants, freight yards, steel works, cement plants, electric plants, etc. The types of cranes illustrated include 3-motor electric travelers, 2-motor electric crane trolley, 4-motor travelers, gantry cranes, handpower and motor-driven transfer cranes, handpower traveling cranes, single and double I-beam handpower cranes, hand and motor operated hoist travelers, cage and floor pendent travelers, air hoist hand traveler, jib cranes, pillar cranes, work-car cranes, locomotive sand truck cranes, etc.

THE FOUNDRY
1892 1917

Vol. 45 No. 9
Cleveland, Ohio, September 1917
Whole No 301

Boston Welcomes the Great Army of Foundrymen

Wonderful Programs Dealing With Every Phase of Foundry Work Have Been Prepared by the Two Technical Associations—The Exhibition and Entertainment Features

BOSTON is the Mecca that will attract the great army of American foundrymen to New England the week of Sept. 24. The concurrent meetings of the American Foundrymen's Association and the American Institute of Metals, and the exhibition of foundry supplies and equipment, machine tools and accessories, will mark an historical event in the industrial life of that wonderful northeastern community. Fifteen years have elapsed since the hospitality of New England was tendered to the casting manufacturers of North America. In 1902, the group of foundrymen who gathered in the metropolis of the Commonwealth of Massachusetts represented the results of six years of organization work by the American Foundrymen's Association. The attendance was less than 300 and in three days the entire business of the meeting was finished. What a wonderful change has taken place in the casting industry since that time is best reflected by a comparison of this affair 15 years ago and today. The attendance has grown from less than 300 to 3000, and more. The exhibits which formerly were limited to placards in hotel corridors have grown to such dimension that they tax the capacity of the most spacious halls in the country's largest cities. The one society has developed into two, the American Institute of Metals being the outgrowth of the brass section of the American Foundrymen's Association. The membership of the latter organization also has grown five-fold, until it numbers among its active supporters the most progressive foundrymen, not only of the United States, but Canada and other foreign countries as well. Since its first meeting in Boston, the American Foundrymen's Association has taken the lead among the societies of casting manufacturers and has made a place for itself in the front rank of the technical bodies of the world. This year five days will be required to dispose of the many features of its lengthy program, involving a total of eight sessions. The American Institute of Metals will hold four meetings, in addition to the joint opening session on Monday, Sept. 24. The program of the American Foundrymen's Association schedules 51 addresses, papers and committee reports and the Institute of Metals, 37. Aside from the opening meeting on Mon-

J. P. PERO, PRESIDENT, AMERICAN FOUNDRYMEN'S ASSOCIATION. JESSE L. JONES (RIGHT), PRESIDENT, AMERICAN INSTITUTE OF METALS

BIRD'S EYE VIEW OF PU

COPLEY SQUARE

OLD CUSTOM HOUSE

BUNKER HILL MONUMENT

NANTASKET BEACH

day afternoon, only morning sessions will be held, leaving the afternoons free for the inspection of the exhibits, entertainment and sight-seeing. To permit of the presentation of the large number of papers on steel, gray iron and malleable subjects, simultaneous sessions of the American Foundrymen's Association will be held Wednesday, Thursday and Friday. In addition to the regular session, Wednesday, Sept. 26, the malleable section will convene to consider eight papers and committee reports. On Thursday, the gray iron and steel sections will meet separately and another gathering of the steel casting manufacturers will be held on Friday in addition to the regular session.

Papers on Munitions Manufacture

One of the features of the program of both organizations is the predominance of papers devoted to the manufacture of implements of war. With foundrymen everywhere enlisted in the service of the country in this great crisis, an opportunity will be presented to study the methods of those who have been most successful in making munitions. This entire event will be a patriotic demonstration of the preparedness of the foundry industry to come to the aid of the country at this time. The large number of labor-saving tools and equipment that will be displayed in Mechanics' building will point the way to increased output, despite reduced operating forces.

The technical sessions of the American Foundrymen's Association will be held in Paul Revere hall and in an adjoining room in Mechanics' building, while the American Institute of Metals will meet at the Hotel Somerset, where its headquarters will be established, with the exception of Monday afternoon when a joint session will be held with the American

EN AND COMMON, BOSTON

Foundrymen's Association in Paul Revere hall. Registration for both societies will be in Mechanics' building throughout the week, and the headquarters for the American Foundrymen will be at the Copley-Plaza hotel.

The Great Exhibition

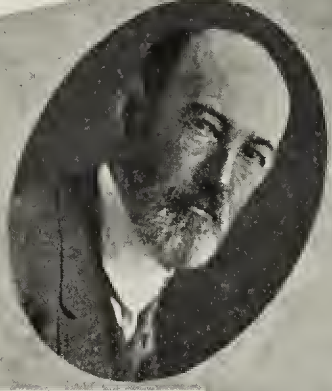
The exhibition of foundry supplies and equipment, machine tools and accessories, in Mechanics' building, will be formally opened Monday at 1 p. m. In extent and number of exhibits, it will greatly surpass the show at Cleveland last year. The operating exhibits will be grouped in sections in Mechanics' building, and the display of molding machines and machine tools promises to eclipse anything of its kind ever undertaken. Mechanics' building practically will be converted into a large foundry and machine shop and demonstrations will be made of the operating and economy-producing features of the latest and most modern equipment.

An entertainment program has been outlined by the foundrymen's committee that measures up to the noted hospitality of New England. On Tuesday afternoon the visitors will be taken on a boat ride in and about Boston harbor, with a stop at Nantasket beach. Wednesday afternoon the foundrymen will be guests at Fenway park to witness a baseball game between the Boston and Cleveland American League teams and in the evening they will attend Keith's theater. Thursday afternoon the General Electric Co. will entertain the visitors at its West Lynn plant where luncheon will be served. The annual banquet will be held Thursday evening at the Copley-Plaza hotel. Two speakers of national reputation will deliver patriotic addresses and the entertainment features will be in accord with the occasion. While facili-

STATE HOUSE

FANEUIL HALL

COMMONWEALTH PIER



WILLIAM A. VIALL
Chairman, Finance Com.

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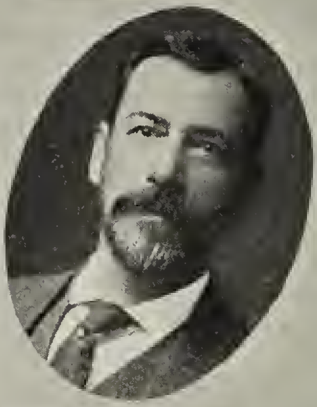

FRED F. STOCKWELL

CHAS. A. REED
Chairman, Entertainment Com.

W. E. FREELAND
Chairman Press Com.

R. D. WALKER
Chairman, Ladies Ent. Com.

Executive Committee of New England Foundrymen in Charge of the Reception and Entertainment of the Visitors ties for plant visitation will be afforded throughout the week, Friday has been specially set apart for this feature. The Walker & Pratt Mfg. Co. will permit of an inspection of its large stove plant at this time and a similar opportunity was presented to the visiting foundrymen at Boston 15 years ago. During this period these works have undergone remarkable development, as illustrated and described elsewhere in this issue.

Ladies' Entertainment

For the ladies an extensive program of entertainment also has been provided. They will be the guests of the New England foundrymen on the boat ride on Tuesday, at Fenway park Wednesday afternoon and at Keith's theater in the evening. Thursday noon they will be tendered a luncheon to be followed by a sight-seeing automobile trip and in the evening they are specially invited to the banquet at the Copley-Plaza hotel, nearly 150 having availed themselves of this opportunity at Cleveland last year.

New England as a Foundry Center

New England, entering its 275th year in the casting of metals, has attained a position in the foundry industry of the United States which bids fair to remain unshaken as long as manufacturing retains its firm grip on the north Atlantic coast. Of the 6000-odd foundries in the country at the present time, over 600, or about 10 per cent are situated in the states of Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont. Gray iron and brass castings were among the earliest products of the New England colonies, and in 1916 the number of iron and nonferrous casting plants in the six states aggregated more than 10 per cent of the total number in the United States. Malleable iron and steel castings were introduced in New England many years after the other branches of the foundry industry had become firmly established. Only 5 per cent of the steel foundries, and 9 per cent of the malleable plants of the country are located in the New England states.

The first iron foundry in New England was built on the west bank of the Saugus river, near the present site of Lynn, Mass. According to early records, the village which grew up around the foundry was called Hammersmith, after a town in England from which several of the workmen had come. Joseph Jenks is reported to have cast "a small iron pot, capable of containing about one quart", which is thought to have been the first casting made in New England. The iron was smelted from bog ore obtained from the low-lying swamp land in what is now eastern Massachusetts.

Hollow-ware was cast as early as 1724 near Taunton, Mass., and in 1725 the foundry was casting hollow vessels varying in size from a pint kettle up to a "10-pail" cauldron. The foundry was rebuilt in 1816, and at the end of that year 30 men were employed at the plant. The product was carried to New York in sloops which brought back pig iron and ore from New Jersey.

Condensed Program

Monday, Sept. 24

10:00 A. M.—Registration, Mechanics' building.

1:00 P. M.—Opening of the exhibition, Mechanics' building.

3:00 P. M. — Joint opening session, American Foundrymen's Association and American Institute of Metals, Paul Revere hall, Mechanics' building.

Tuesday, Sept. 25

9:30 A. M.—Professional session, American Institute of Metals, Hotel Somerset, for the discussion of the melting and casting of nonferrous metals.

10:00 A. M.—Professional session, American Foundrymen's Association, Paul Revere hall, Mechanics' building; general topics.

1:30 P. M.—Boat ride, in and about Boston harbor. Luncheon will be served on board.

Wednesday, Sept. 26

9:30 A. M.—Professional session, American Institute of Metals, Hotel Somerset, for the discussion of the uses of nonferrous metals for munitions.

10:00 A. M.—Professional session, American Foundrymen's Association, Paul Revere hall, Mechanics' building; cost-keeping in foundries and general topics.

10:00 A. M.—Malleable session, Mechanics' building.

3:00 P. M.—Baseball game, Fenway park, Boston and Cleveland American League teams.

8:15 P. M.—Theater party.

Thursday, Sept. 27

9:30 A. M.—Professional session, American Institute of Metals, Hotel Somerset, for the consideration of the testing of metals.

10:00 A. M.—Gray iron session, American Foundrymen's Association, Paul Revere hall, Mechanics' building

10:00 A. M.—Steel session, American Foundrymen's Association, Mechanics' building.

12:00 M.—Luncheon for the ladies, followed by an automobile sightseeing tour.

12:30 P. M.—Visit to the West Lynn plant of the General Electric Co. Lunch will be served at the works.

7:00 P. M.—Annual banquet, Copley-Plaza hotel.

Friday, Sept. 28

9:30 A. M.—Professional session, American Institute of Metals, Hotel Somerset, for the discussion of metallurgy and metallography.

10:00 A. M.—Professional session, American Foundrymen's Association, Paul Revere hall, Mechanics' building; general topics.

10:00 A. M.—Steel session, American Foundrymen's Association, Mechanics' building.

Plant visitation.

These foundries were the forerunners of many others which came into existence in the eighteenth century. In 1784 there were 76 iron works in New England. Although many of these were bloomeries and forge shops, it is thought that about 20 were engaged in making castings. In the north end of Boston, Paul Revere established a bell and cannon foundry which was in operation until 1801, when he erected a copper-rolling mill at Canton, Mass. Hugh Orr operated a foundry at Bridgewater, Mass., before the revolution. Cannon were cast solid and then bored in this shop, and machinery castings were made. In 1829 the first stove foundry in the United States was erected at Taunton, Mass., and in a few years the making of castings for stoves and heating appliances became an important industry.

Foundries in Revolutionary Period

The development of the foundry industry from the time of the American revolution was influenced to a considerable extent by the gradually changing economic position of New England in the United States. Massachusetts, Connecticut and Rhode Island, which for many years had provided the other states with practically all of the manufactured goods which they used, were obliged to relinquish their hold on several important industries. The blast furnaces of Salisbury gave way to those in the Pittsburgh district, and several other lines of manufacturing were established in the west where raw materials were more easily obtained. In the meantime, however, the Yankee ingenuity of the New Englanders had given them a firm hold on certain industries, many of which are peculiar to New England to this day. Clocks, small tools, hardware, paper, cotton and woolen cloth, paper, silverware and fine machine tools and brass goods became the principal products, and it is to the success achieved in producing these articles that the foundry industry in New England owes its prosperity.

In general, the majority of New England foundries are engaged in making castings for the machinery which produces the typical products enumerated, and in providing rough castings from which the products are made. The output of many foundries is required to supply the 900 boot and shoe manufacturing establishments of Massachusetts with the necessary machine equipment. This is also true of the hundreds of textile plants, the

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The Men Who Raised the Money and the Committee that Will Entertain the Visiting Ladies

Program, American Foundrymen's Association

Monday, Sept. 24

10:00 A. M.—Registration, Mechanics' building.

1:00 P. M.—Opening of exhibition, Mechanics' building.

3:00 P. M.—Joint opening session, American Foundrymen's Association and American Institute of Metals, Paul Revere hall, Mechanics' building.

Address of welcome, by Hon. James M. Curley, mayor of the City of Boston.

Response to the address of welcome, by R. A. Bull, Duquesne Steel Foundry Co., Coraopolis, Pa.

Annual address by J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill., president, American Foundrymen's Association.

Annual address by Jesse L. Jones, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., president, American Institute of Metals.

Report of the executive board of the American Foundrymen's Association.

Report of the secretary-treasurer of the American Foundrymen's Association, by A. O. Backert, Cleveland.

"Fire Prevention in Large Industrial Establishments," by C. W. Johnson, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Appointment of nominating committee and committee on resolutions.

Tuesday, Sept. 25, 10:00 A. M., Paul Revere Hall

"The Foundry From the Viewpoint of the Sales Engineer," by H. R. Atwater, Osborn Mfg. Co., Cleveland.

"The Relationship of the Engineering Department to the Pattern Shop and Foundry," by F. J. McGrail, Struthers-Wells Co., Warren, Pa.

"How Character Analysis Solves the Man Problem," by William Judson Kibby, Cleveland.

Report of A. F. A. committee advisory to the U. S. bureau of standards, by Richard Moldenke, chairman, Watchung, N. J.

"Efficiency in the Foundry," by James A. Fitzgerald, Reno, Pa.

"Co-Operative Shop Training," by W. B. Hunter, Fitchburg high school, Fitchburg, Mass.

1:30 P. M.—Boat ride in and about Boston harbor. Luncheon will be served on board.

Wednesday, Sept. 26, 10:00 A. M., Paul Revere Hall

"Improving the Relationship Between Employer and Employe," by J. F. Kent, American Cast Iron Pipe Co., Birmingham, Ala.

Report of A. F. A. committee on safety, sanitation and fire prevention, by Victor T. Noonan, chairman, Industrial Commission of Ohio, Columbus, O.

Report of A. F. A. committee on foundry costs, by B. D. Fuller, chairman, Westinghouse Electric & Mfg. Co., Cleveland.

Address on the cost work of the American Foundrymen's association, by C. E. Knoeppel, C. E. Knoeppel & Co., New York.

Report of A. F. A. representatives on the conference board on training of apprentices, by Frank M. Leavitt, chairman, University of Illinois, Chicago.

"The Labor Situation as Relating to Co-Operation Between the Employer and Employe," by G. E. Mac Ilwain, Babson's Statistical Organization, Wellesley, Mass.

"Micro-Metallography for the Foundry," by Robert J. Anderson, Cleveland Metal Products Co., Cleveland.

Report of nominating committee and election of directors.

Wednesday, Sept. 26, 10:00 A. M., Mechanics' Bldg.

Malleable Session

"The Theory of the Modern Waste-Heat Boiler and Possible Application of Such Boilers to the Malleable Melting Furnace," by A. D. Pratt, Babcock & Wilcox Co., New York.

"Application of Waste-Heat Boilers to the Malleable Melting Furnace," by C. D. Townsend, Danville Malleable Iron Co., Danville, Ill.

"Application of Pulverized Coal to the Air Furnace," by W. R. Bean, Naugatuck Malleable Iron Works, Naugatuck, Conn.

"The Application of Pulverized Coal to Malleable Melting Furnaces," by Joseph Harrington, Chicago.

"How Malleable Iron Has Improved," by Enrique Touceda, Albany, N. Y.

"Troubles Encountered in Machining Malleable Iron: Causes and Remedies," by A. T. Jeffery, Dayton Malleable Iron Co., Dayton, O.

"Comparative Carbon Losses in Malleable Iron Annealing by Muffle and Pot Oven Methods," by Joseph B. Deisher, T. H. Symington Co., Rochester, N. Y.

"The Effect of Iron Oxide in Molding Sand," by W. R. Bean, Naugatuck Malleable Iron Works, Naugatuck, Conn.

3:00 P. M.—Baseball game, Fenway Park, Boston and Cleveland American League teams.

8.15 P. M.—Theater party.

Thursday, Sept. 27, 10:00 A. M., Paul Revere Hall

Gray Iron Session

"Note on Fine Molding Sands," by C. P. Karr, U. S. bureau of standards, Washington, D. C.

Report of A. F. A. committee on general specifications for gray iron castings, by W. P. Putnam, chairman, Detroit Testing Laboratory, Detroit.

"Briquetting Foundry Borings," by A. L. Stillman, General Briquetting Co., New York.

"Cast Iron Shells in Permanent Molds," by Edgar Allen Custer, Philadelphia.

"The Seasoning of Gray Iron Castings," by L. M. Sherwin, Brown & Sharpe Mfg. Co., Providence, R. I.

"Factors in the Economical Production of Small Cores in Large Quantities," by R. E. Kennedy, University of Illinois, Urbana, Ill.

"Modern Centrifugal Cupola Blowers," by J. W. Shugg, General Electric Co., Schenectady, N. Y.

"The Effect of High Sulphur in Gray Iron Castings," by T. Mauland, International Harvester Co., Chicago.

Thursday, Sept. 27, 10:00 A. M., Mechanics' Building

Steel Session

"Molding and Casting Large Slag Pots," by C. J. McMahon, Illinois Steel Co., Chicago.

"A Description of a Small Open-Hearth Furnace," by David McLain, McLain's System, Milwaukee.

"Small Steel Castings for Ordnance Purposes," by Major C. M. Wesson, Watertown Arsenal, Watertown, Mass.

"A New System of Burning Crude Oil," by W. A. Janssen, Davenport, Iowa.

"The Use of Vanadium in Steel Castings," by J. Lloyd Uhler, Union Steel Castings Co., Pittsburgh.

"Report of A. F. A. committee on steel foundry standards, by W. A. Janssen, chairman, Davenport, Ia.

12:00 M.—Luncheon for the ladies, followed by an automobile sightseeing tour.

12:30 P. M.—Visit to the West Lynn plant of the General Electric Co. Luncheon will be served at the works.

7:00 P .M.—Annual banquet, Copley-Plaza hotel.

Friday, Sept. 28, 10:00 A. M., Mechanics' Building

Steel Session

"Electric Furnace Design," by John A. Crowley, John A. Crowley Co., Detroit.

"Recent Developments in the Application of the Electric Furnace to the Melting Problem," by Douglas Walker, Booth-Hall Co., Chicago.

"Comparison of Electric Furnace and Steel Converter for the Manufacture of Small Steel Castings," by C. R. Messinger, Sivyer Steel Casting Co., Milwaukee.

"The Electric Furnace From the Central Station Standpoint," by E. L. Crosby, Detroit Edison Co., Detroit.

"The Electric Furnace in the Iron and Steel Foundry," by Max Trembour, Ludlum Steel Co., Watervliet, N. Y.

Friday, Sept. 28, 10:00 A. M., Paul Revere Hall

"Solution of Foundry Transportation and Conveying Problems," by Robert E. Newcomb, Deane Works, Worthington Pump & Machinery Corp., Holyoke, Mass.

"Sand-Blasting in the Foundry," by H. L. Wadsworth, American Foundry Equipment Co., Cleveland.

"Results of Tests in Blending and Mixing Sand by Means of Mullers," by R. F. Harrington, Hunt-Spiller Mfg. Corp., Boston.

"Factors Contributing to the Economical Use of Grinding Wheels in the Foundry," by Wallace T. Montague, Norton Co., Worcester, Mass.

"Refractory Materials Employed in the Metallurgical Industries," by H. C. Arnold, University of Illinois, Urbana, Ill.

Installation of officers.

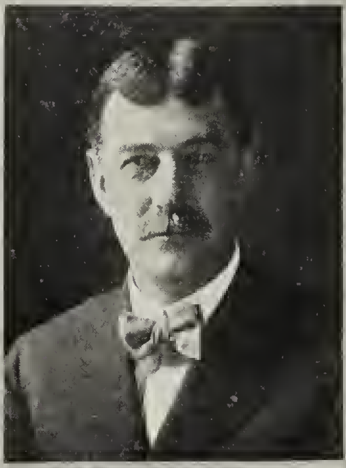
Plant visitation.

C. A. WYATT
Golf Com.

ROBERT E. NEWCOMB
Reception Com.

A. E. BLAZO
Golf Com.

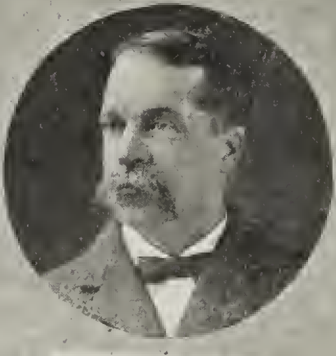
H. PAUL BUCKINGHAM
Reception Com.

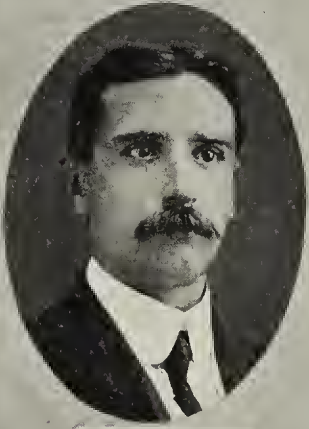

E. A. TUTEIN
Chairman Reception Com.

GEORGE H. GIBBY
Reception Com.

R. CLINTON FULLER
Reception Com.

H. F. WINLOCK
Reception Com.


F. B. FARNSWORTH
Reception Com.


GEORGE A. RAY
Reception Com.

W. SCOTT THOMAS
Reception Com.

Members of the Golf and Reception Committees for the Great Boston Meeting of Foundrymen

00 carriage and wagon shops, the 00 machine tool builders, 100 manu-acturers of electrical machines, etc. nother outlet for castings are the athes, chucks, planers, shapers, drill resses, levels, planes, motors, sewing nachines, meat choppers, printing resses, laundry machines, locks, type-vriters, adding machines, engines, marine motors, propellers, gun mounts and carriages, etc., which are turned out by the thousands in New England's many shops. The foundry industry supplements other lines of manufacturing, and is indispensable to the future development of the district. Referring to Table II, which shows the number of foundries in each of the six states, it will be noted that there were 372 casting plants producing gray iron in New England in 1916. A careful study of the distribution of these foundries throughout the towns and villages of New England shows that the plants are widely scattered. There are few towns, even the smallest villages, which do not boast of a foundry. In size, the castings shops vary from those which melt a few tons at irregular periods to the larger ones which melt upwards of 150 tons daily. That a large percentage of the foundries, especially those in outlying towns and villages, are small, is indicated by the thirteenth census report for Connecticut which shows that of the 403 establishments listed as "foundries and machine shops", 18 employed no wage earners, 116 employed from one to five, 85 from six to 20, 69 from 21 to 50, 40 from 51 to 100, 44 from 101 to 250, 16 from 251 to 500, eight from 501 to 1000, and seven over 1000 employes. In other words, about 50 per cent of the plants employ less than 20 men.

The larger gray iron foundries are in many cases departments of extensive manufacturing plants. This is especially true of the foundries making

Program, American Institute of Metals

Monday, Sept. 24

10:00 A. M.—Registration, Mechanics' building.

3:00 P. M.—Joint opening session American Foundrymen's Association and American Institute of Metals, Paul Revere hall, Mechanics' building

Tuesday, Sept. 25, 9:30 A. M., Hotel Somerset

Melting and Casting Nonferrous Metals

"Raw Materials Used for Crucibles," by Prof. A. V. Bleininger, bureau of standards, Washington, D. C.

"Melting Yellow Brass in New Form of Induction Furnace," by G. H. Clamer, Ajax Metal Co., Philadelphia.

"Casting Bearings in Sand and Metal Molds," by R. R. Clarke, Pennsylvania Lines West of Pittsburgh, Pittsburgh.

"Negative Experiments on Waste Core Sand," by Dr. H. W. Gillett, bureau of mines, Ithaca, N. Y.

"The Crucible Situation," by M. McNaughton, Jos. Dixon Crucible Co., Jersey City, N. J.

'The Electric Furnace and Nonferrous Metals," by Dwight D. Miller, Society for Electrical Development, New York.

"My Experience with Metal Melting Furnaces," by W. H. Parry, National Meter Co., Brooklyn, N. Y.

"The Briquetting of Nonferrous Light Metal Scrap," by A. L. Stillman, General Briquetting Co., New York.

1:30 P. M.—Boat ride in and about Boston harbor. Luncheon will be served on board.

Wednesday Sept. 26, 9:30 A. M., Hotel Somerset

Uses of Nonferrous Metals for Munitions, Etc.

"The Present Status of Tin Fusible Plug Manufacture and Properties," by Dr. George K. Burgess, bureau of standards, Washington, D. C.

"Stellite," by Elwood Haynes, Haynes Stellite Works, Kokomo, Ind.

"The Use of Die Castings in Munitions," by Chas. Pack, Doehler Die Casting Co., Brooklyn, N. Y.

"Shrapnel Bullets," by Harold J. Roast, Jas. Robertson Co., Ltd., Montreal, P. Q.

"A Few Points on Alloy Patents," by Wm. J. Rich, patent office, Washington, D. C.

Address by a representative of the United States tariff commission.

"The Use of Bronzes in Railroad Turntables and Movable Bridges," by O. E. Selby, Big Four railroad, Cincinnati.

"Recent Industrial Uses of Aluminum," by F. G. Shull, Aluminum Co. of America, Boston.

"The Consumption of Copper and Its Varied Uses," by H. D. Hawks, United Metals Selling Co., New York.

3:00 P. M.—Baseball game, Fenway park, Boston and Cleveland American League teams.

8:15 P. M.—Theater party.

Thursday, Sept. 27, 9:30 A. M., Hotel Somerset

Testing of Nonferrous Metals

"Comparative Tests on Test Bars and Actual Castings," by W. M. Corse, Titanium Bronze Co., Niagara Falls, N. Y.

"Analysis of Babbitts and Brasses," by E. W. Hagmaier, Buffalo.

"Standard Test Bars of 88-10-2 and 88-8-4, being the result of co-operative work of six foundries; a new series of tests," by C. P. Karr, bureau of standards, Washington, D. C.

"The Expansion Coefficients of Alpha and Beta Brass" and "The Corrosion of Manganese Bronze Under Stress," by Dr. Paul D. Merica, bureau of standards, Washington, D. C.

"Corrosion of Brasses of the Muntz Metal Type," by H. S. Rawdon, bureau of standards, Washington, D. C.

Address by Richard C. Maclaurin, president, League to Enforce Peace.

"The School End of the Job in Training Foundrymen," by Dean C. B. Connelley, Carnegie Institute of Technology, Pittsburgh.

"The Flux and Cleaner Question of Brass," by E. D. Frohman, S. Obermayer Co., Pittsburgh.

"Pyrometers—Their Construction and Application," by John P. Goheen, Brown Instrument Co., Philadelphia.

"Electrically-Heated Core Ovens," by Dr. C. F. Hirshfeld, Edison Illuminating Co., Detroit.

"Brass Rolling Mill Alloys," by Roy A. Wood, Cheshire, Conn.

12:00 M.—Luncheon for the ladies, followed by an automobile sightseeing tour.

12:30 P. M.—Visit to the West Lynn plant of the General Electric Co. Luncheon will be served at the works.

7:00 P. M.—Annual banquet, Copley-Plaza hotel.

Friday, Sept. 28, 9:30 A. M., Hotel Somerset

Metallurgy and Metallography

"The Electrolytic Production of Antimony," by Prof. D. J. Demorest, Ohio State University, Columbus, O.

"The Electrical Properties of Some High Resistance Alloys," by Prof. M. A. Hunter, Rensselaer Polytechnic Institute, and F. M. Sebast, Troy, N. Y.

"The Amorphous Theory in Metals," by Zay Jeffries, Aluminum Castings Co., Cleveland.

"The Volatility of Zinc and Cadmium," by John Johnston and Edward Schramm, American Zinc, Lead & Smelting Co., St. Louis.

"Surface Tension and Deoxidizing of Metals," by W. J. Knox, Metals Deoxidizing & Refining Co., New York.

"Antimony—Its Metallurgy and Uses," by K. C. Li, Wah Chang Mining & Smelting Co., Inc., New York.

"Development and Reabsorption of the Beta Constituent in Alloys which are Normally of the Alpha Type," by Prof. C. H. Mathewson, department of mining and metallurgy, Yale University, and Philip Davidson, New Haven, Conn.

"The Swelling of Zinc Base Die Castings," by H. M. Williams, National Cash Register Co., Dayton, O.

Plant visitation.

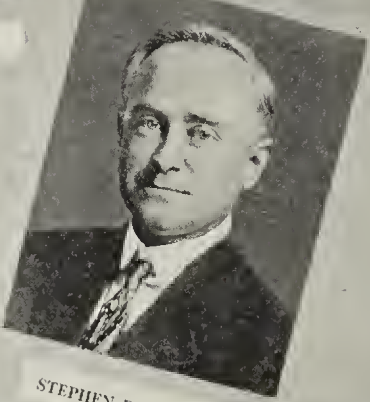
E. B. FREEMAN

THOMAS T. CURTIN

GEORGE P. ABORN

B. S. LESLIE

C. L. NUTTER



STEPHEN E. FRENCH

H. A. NEALLEY

C. A. OLSON

CHAS. V. S. PAUL

D. F. EAGAN

The Committee that Will See to It that the Visiting Foundrymen Are Well Entertained

Members, New England Convention Committees

Executive Committee

W. J. Lavelle, chairman, New England Coal & Coke Co., Everett, Mass.
J. O. Henshaw, 79 Milk street, Boston.
C. A. Reed, Reed, Fears & Miller, Boston.
R. D. Walker, Walker & Pratt Mfg. Co., Boston.
W. E. Freeland, *The Iron Age*, Worcester, Mass.
A. R. Plant, Blackstone National bank, Providence, R. I.
W. A. Viall, Brown & Sharpe Mfg. Co., Providence, R. I.
Fred F. Stockwell, Barbour-Stockwell Co., Cambridge, Mass.
A. B. Root Jr., Hunt-Spiller Mfg. Corp., Boston.
T. R. Scott, Brown & Sharpe Mfg. Co., Providence, R. I.

Reception Committee

E. A. Tutein, chairman, 53 State street, Boston.
H. Paul Buckingham, Arcade Malleable Iron Co., Worcester, Mass.
H. E. Winlock, Barbour-Stockwell Co., Cambridge, Mass.
George H. Gibby, Gibby Foundry Co., E. Boston, Mass.
W. Scott Thomas, J. W. Paxson Co., Providence, R. I.
F. B. Farnsworth, McLagon Foundry Co., New Haven, Conn.
George A. Ray, Taylor & Fenn Co., Hartford, Conn.
H. W. Woodworth, American Tool & Machine Co., Boston.
Charles Van Stone, Lumsden & Van Stone Co., South Boston, Mass.
D. D. Barlett, Builders Iron Foundry, Providence, R. I.
F. W. Stickle, Capitol Foundry Co., Hartford, Conn.
Robt. E. Newcomb, Deane Steam Pump Works, Holyoke, Mass.
R. C. Fuller, Fuller Iron Works, Providence, R. I.

Finance Committee

W. A. Viall, chairman, Brown & Sharpe Mfg. Co., Providence, R. I.
H. A. Carpenter, General Fire Extinguisher Co., Providence, R. I.
W. J. Breen, Wm. J. Breen Co., Boston.
A. N. Abbe, American Hardware Corp., New Britain, Conn.
A. R. Plant, Blackstone National Bank, Providence, R. I.
A. J. Miller, Whitehead Bros. Co., Providence, R. I.
W. C. Fish, General Electric Co., Lynn, Mass.
L. G. Kibbe, Turner & Seymour Mfg. Co., Torrington, Conn.

Ladies Entertainment Committee

R. D. Walker, chairman, Walker & Pratt Mfg. Co., Boston.
L. S. Brown, Springfield Facing Co., Springfield, Mass.
Charles L. Newcomb, Deane Steam Pump Works, Holyoke, Mass.
Robert C. Bird, Broadway Iron Foundry, Cambridge, Mass.
Carl S. Dixon, General Electric Co., Pittsfield, Mass.
W. H. Coffin, Springfield Facing Co., Springfield, Mass.
J. F. Lanigan, Davis Foundry Co., Lawrence, Mass.
W. M. Saunders, Saunders & Franklin, Providence, R. I.

Entertainment Committee

C. A. Reed, chairman, Reed, Fears & Miller, Boston.
W. T. Bennett, secretary, Griffin Wheel Co., Chelsea, Mass.
S. E. French, Athol Machine Works, Athol, Mass.
T. Officer, Sullivan Machinery Co., Claremont, N. H.
A. F. Corbin, Union Mfg. Co., New Britain, Conn.
H. A. Nealley, Jos. Dixon Crucible Co., Boston.
G. P. Aborn, Blake & Knowles Steam Pump Works, Cambridge, Massachusetts.
C. A. Olson, Walworth Mfg. Co., Boston.
B. S. Leslie, United Shoe Machinery Co., Beverly, Mass.
T. R. Scott, Brown & Sharpe Mfg. Co., Providence, R. I.
Chas. V. S. Paul, R. Estabrook's Sons, Boston.
Charles L. Nutter, Old Colony Foundry, Bridgewater, Mass.
C. E. Hildreth, Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
E. B. Freeman, B. F. Sturtevant Co., Hyde Park, Mass.
D. F. Eagan, Hotel Seymour, Lynn, Mass.
T. I. Curtis, Waltham Foundry Co., Waltham, Mass.
A. L. Haasis, Jos. Dixon Crucible Co., Jersey City, N. J.

Golf Committee

J. O. Henshaw, chairman, 79 Milk street, Boston.
R. E. Blazo, Rogers, Brown & Co., Boston.
C. A. Wyatt, Debevoise-Anderson Co., Boston.
Thomas F. Stokes, Alley & Page Co., Boston.

Press Committee

W. E. Freeland, chairman, *The Iron Age*, Worcester, Mass.
A. W. Howland, New York.
A. O. Backert, Cleveland.

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castings for textile and electrical machinery and machine tools. A number of the gray iron jobbing foundries have developed comparatively large volumes of business, one concern of this kind in southern New England having a capacity of about 150 tons daily. Manufacturing stoves is an important branch of the gray iron foundry industry in New England. According to late figures there are about 20 stove foundries in this section, half of this number being in the state of Massachusetts. A description of one of the leading plants appears elsewhere in this issue of THE FOUNDRY.

Table I

FOUNDRIES IN NEW ENGLAND, 1894 TO 1917

	1894	1900	1904	1906	1908	1910	1912	1914	1916	1917
Connecticut	112	103	187	156	158	169	170	167	169	176
Maine	48	47	57	48	48	48	49	45	43	44
Massachusetts	176	167	272	247	264	276	282	282	273	294
New Hampshire	34	36	41	38	36	37	37	36	37	38
Rhode Island	29	30	54	48	41	41	40	42	41	43
Vermont	24	34	35	31	32	31	28	28	25	25
Total New England	423	417	646	568	579	602	606	600	588	622

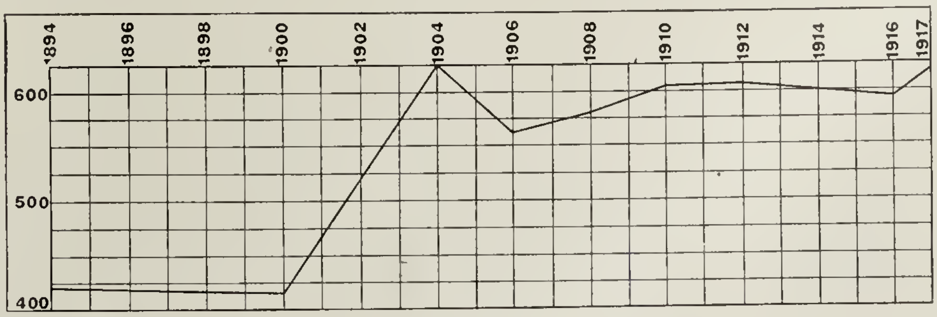


CHART SHOWING THE INCREASE IN THE NUMBER OF FOUNDRIES IN NEW ENGLAND SINCE 1894.

Data for years 1894 to 1916, inclusive, compiled from *Penton's Foundry List.* Number of foundries in 1917 estimated.

Table II shows that there are 347 foundries in New England casting brass and 229 melting aluminum. Brass is melted exclusively in 188 of these foundries, and in the remaining 159, brass is only one of two or more metals cast. The growth of the brass foundry industry in Massachusetts and Connecticut has been stimulated by the success of hardware manufacture in these states and by the demand for brass castings for machinery. It is not surprising that 104 brass foundries are in Connecticut, for almost nine-tenths of the rolled brass products manufactured in the United States are made in that state. While many of the brass foundries are identified with concerns primarily engaged in the rolled brass industry, the product of a large number of the casting plants finds its way into builders' hardware, machine bearings, valves and fittings, plumbers' goods, etc. According to *Penton's Foundry List*, there were 18 malleable iron foundries in New England in 1916. Without exception, the 11 malleable plants in Connecticut are situated in the southwestern part of the state, and most of them are in the Naugatuck valley. Four of the largest malleable casting plants are controlled by a single company, which operates similar plants in other eastern states. The product of the Connecticut malleable foundries is used in hardware specialties; fittings for gas, steam and water lines; laundry machinery; railway car castings, etc. Two of the four malleable plants of Massachusetts are in Boston, and there is one malleable foundry in Rhode Island and one in New Hampshire.

Table II

FOUNDRIES IN NEW ENGLAND COMPARED WITH FOUNDRIES IN UNITED STATES IN 1916

	Total	Gray iron	Exclusive brass	Brass, departments of other shops	Total brass	Malleable	Steel	Melting aluminum
Connecticut	169	88	69	35	104	11	2	66
Maine	43	36	7	26	33	..	..	17
Massachusetts	273	172	88	55	143	4	13	102
New Hampshire	37	29	7	16	23	2	..	18
Rhode Island	41	24	15	10	25	1	1	17
Vermont	25	23	2	17	19	..	..	9
Total New England	588	372	188	159	347	18	16	229
Total United States	5741	4267	1160	1979	3139	197	304	2121
Per cent	10.24	8.70	10.17	8.03	11.05	9.13	5.26	10.79

Data compiled from *Penton's Foundry List*.

Manufacturing steel castings was not attempted in New England until long after the other branches of the foundry industry had been firmly established. New Hampshire, Vermont, Massachusetts and Connecticut were making steel castings in 1880 and Massachusetts, Rhode Island and Connecticut were producing converter steel castings in the early part of the present century. One manufacturer of electrical machinery was operating three basic open-hearth furnaces in 1905 with a daily capacity of 45 tons. A foundry and machine company in that year had a crucible plant of 100 pots with a capacity of 4 tons daily. A Connecticut steel foundry was then producing 3½ tons per day. In 1916 there were two steel casting plants in Connecticut, 13 in Massachusetts and one in Rhode Island. Of the total number in New England, about one-half are operated as departments of manufacturing companies which use steel castings in their primary products. The others are departments of jobbing foundries, some of which are equipped to cast brass, gray iron, malleable iron and steel. The jobbing steel foundry, producing steel castings exclusively, has not gained the foothold in New England that it has in the middle west, where it owes its prosperity to the automobile industry.

The electric steel industry is comparatively new in New England, and promises to become firmly established in a few years. The first electric furnace in this part of the country was installed by a tool and hardware manufacturer to make castings for his own use. Strangely enough, the first jobbing electric steel foundry, completed a few months ago in Hartford, more nearly approaches the type of plant adopted in Pennsylvania, Ohio and Illinois than any other foundry in New England. Whereas most of the foundries in the east are of mill construction, employing wood almost exclusively, this electric steel plant is constructed of sheet metal on steel framework, steel sash providing unusually large window areas. A 2-ton heroult furnace is now in operation and another will be installed as soon as the buildings now about to be erected are completed. The Connecticut Electric Steel Co., which operates this plant, designed it for making small castings, but quickly engaged in making gun mounts for the United States navy and castings for anti-aircraft truck mounts for the army. Thus New England's first electric steel foundry has entered a field of extreme usefulness in assisting the government to wage war.

New England foundries are assuming their fair share in producing castings for the government's war needs. The manufacture of ships, gun mounts, ammunition, wire goods, stoves and other cantonment equipment is imposing a demand for castings to which the foundries are nobly responding. In many casting plants a large proportion, and in a few all of the capacity is engaged in government work.

The mid-year period of 1917 finds the foundry industry in an unusually prosperous condition. According to various sources of information, it is estimated that there are now 622 casting plants operating in New England.

What You Will See at the Boston Exhibition

ABELL-HOWE CO., Chicago.—A one-man detachable tongue truck in two or three types, indicative of the manner in which this truck accommodates itself to the handling of various materials, will be exhibited. High speed chain also will be shown, suitable for the driving of blowers, machine tools or for the general transmission of power in foundries and machine shops. A display also will be made of electric hoists; represented by Oliver J. Abell.

AJAX METAL CO., Philadelphia.—In addition to having its space fitted up as a reception room for visiting foundrymen, this company will exhibit its line of ingot metals together with a variety of castings made from them; represented by Frank M. Willeson, G. H. Clamer, Chas. F. Hopkins, Jos. C. Brightbill, and J. Millson Graham.

ALBANY SAND & SUPPLY CO., Albany, N. Y.—A stove built by the Walker-Pratt Mfg. Co., Boston, all the parts of which were cast in Albany sand furnished by the Albany Sand & Supply Co., will be exhibited. In addition this space will be fitted up as a rest room for the many friends of this concern; represented by Lawrence Murray and Chas. H. Bird.

AMERICAN FOUNDRY EQUIPMENT CO., New York.—This exhibit will consist of a sand cutting machine; rotary table sand-blast room; humane sand-blast rotary table in which the operator stands outside and is immune from dust; a large sand-blast tumbling barrel and a new type of humane sand-blast room for handling all kinds of small work; represented by V. E. Minich, H. L. Wadsworth, Hutton H. Haley, J. D. Alexander and Charles G. Smith.

AMERICAN GUM PRODUCTS CO., New York.—The core binder manufactured by this company will be exhibited; represented by Gordon I. Lindsay.

AMERICAN LIGHTING CO., Chicago.—Industrial and railroad flood lights will be exhibited, these units using 750 or 1000-watt standard lights with a glass reflector, highly silvered and polished. These lights are used extensively in foundry operations where night work is carried on; represented by W. J. Davis Jr., F. M. Evans and J. C. Starr.

AMERICAN MOLDING MACHINE CO., Terre Haute, Ind.—A 10-inch jolt-ramming rock-over molding machine, provided with a table 30 x 40 inches, will be shown in operation, as well as a jolt-ramming stripping plate machine with a 12-inch draw and a 24 x 36-inch table; represented by W. C. Norcross and L. J. Cox.

AMERICAN PIPE BENDING MACHINE CO., Boston. — The pipe bending machine built by this company will be shown in operation; represented by Mark Angel, James Heggie, John Heggie and E. P. Blake.

ARCADE MFG. CO., Freeport, Ill.—The line of molding machines to be exhibited by this company will include a 24-inch electrically-operated, roll-over jolt-ramming and pattern-drawing machine; two sizes of jolt-ramming machines, one showing a ferrule plate; piston cope and drag machines; a combined jolt-ramming and squeezer machine; air and hand squeezer machines; midget core jolt-ramming machine; 17½-inch jar-ramming machine and a pouring device; represented by E. H. Morgan, Chas. Morgan, L. L. Munn, R. E. Turnbull, Henry Tscherning, August Christen and G. D. Wolfley.

ARMSTRONG CORK CO., Pittsburgh.—Insulating brick for furnaces, ovens, boiler settings, etc., high pressure covering for steam lines, corkboard insulation for cold storage rooms, cork covering for drinking water systems for mills and factories and cork machinery isolation for deadening the noise of machines, will be displayed. In addition, an electrically-heated furnace will be shown in operation for demonstrating the non-conducting properties of insulating brick.

ATHOL MACHINE CO., Athol, Mass.—Vises of many types and an extensive assortment of mechanics' tools will be displayed. Photographs of the company's plant also will be shown, illustrating the play-grounds, baseball and basket ball fields, club house and safety devices in the company's shops; represented by Stephen E. French and H. K. Parkman.

ATKINS, E. C., & CO., Indianapolis, Ind. —An extensive display will be made of saws of all kinds, including metal-cutting circular saws, hack saw blades, frames, hand saws, metal-cutting machines and foundry plates; represented by T. H. Endicott, W. L. Timpone, Geo. W. Steenberg and Thos. A. Carroll.

AYER & LORD TIE CO., Chicago.—The interior creosoted wood blocks manufactured by this company will be installed in the floor of its booth and photographs and other data, descriptive of this type of material will be shown; represented by A. Y. Noyes, W. H. Blythe, B. S. McConnell, F. W. Decker, R. H. and R. G. Inslee and H. G. Stephens.

B. & B. MFG. CO., Indianapolis.—Several types of the molding machines made by this company will be shown and both power and hand squeezers of the portable and stationary types will be demonstrated.

BEAUDRY & CO., INC., Boston.—A 100-pound power hammer arranged for motor drive and a similar power hammer of 50 pounds capacity, built by the United Hammer Co., Boston, will be displayed; represented by O. H. Abramson and A. Parsons.

BERKSHIRE MFG. CO., Cleveland. — An air squeezer, equipped with a vibrator and a lifting device will be displayed. In addition a complete line of aluminum, wood and iron flasks and special aluminum match-plates will be exhibited; represented by R. H. York, W. A. Price, G. L. Cannon and W. D. Fraser.

BESLY, CHARLES H., & CO., Chicago.—An operating exhibit, consisting of the following machines will be made: A 53-inch vertical spindle disc grinder, 24-inch wide faced ring wheel grinder with 30-inch disc wheel for finish grinding, 20-inch double spindle disc grinder and a 30-inch patternmakers' disc grinder; represented by Edward P. Wells, Charles A. Knill, Ralph W. Young and J. F. Curns.

BIRKENSTEIN, S., & SONS, Chicago.—A complete line of non-ferrous metals and alloys will be exhibited, including ingot brass, ingot bronze, ingot copper, pig tin, pig lead, solder, babbitt, phosphor-copper, phosphor-tin, manganese bronze, etc. Castings made from these ingots also will be displayed.

BLODGETT, G. S., CO., Burlington, Vt.—Two or three samples of the core-baking ovens manufactured by this company will be exhibited; represented by R. L. Patrick.

BLYSTONE MFG. CO., Cambridge Springs, Pa.—A core sand mixer with screen, motor and power discharge attached will be exhibited; represented by Luther G. Conroe and T. A. Graham.

BRIDGEPORT SAFETY EMERY WHEEL CO., Bridgeport, Conn.—Belt and motor-driven grinding and polishing machinery, together with a number of grinding wheels will be exhibited. A portion of this machinery display will be operated; represented by D. T. Homan.

BROWN SPECIALTY MACHINERY CO., Chicago.—Two styles of core machines, one of which will be operated, and an electric duplex shaker will be shown, in addition to a revolving barrel sand-blast machine equipped with cloth screen type dust arrester and exhaust fan, which will be in operation; represented by Elmer A. Rich Jr., J. E. Sweet, R. E. Laycock, J. L. Laycock and R. G. Coburn.

BUCKEYE PRODUCTS CO., Cincinnati.—Metal melting crucible and non-crucible furnaces will be exhibited as well as air and electric vibrators, parting and core compounds, fluxes, etc.; represented by C. J. Goehringer, D. S. Marfield, B. Bernbaum, C. Gysin, J. B. Carpenter and E. R. Sutton.

CARBORUNDUM CO., Niagara Falls, N. Y.—Carborundum and aloxite wheels, special carborundum wheels for malleable grinding and samples of crude material from which these wheels are made will be shown. The booth of this company also will be fitted up as a rest and reception room for visitors; represented by C. E. Hawke, J. E. Rayner, John MacArthur, H. E. Hammond, G. E. Dresser, O. C. Dobson and H. E. Kerwin.

CATARACT REFINING & MFG. CO., Buffalo.—Core oils, parting compounds, cutting oils and quenching and tempering oils will be exhibited; represented by J. Purvis, A. A. Schaefer, F. F. Hennessy, J. A. MacVeagh, M. E. Becker and F. N. Tweedy.

CHAMPION FOUNDRY & MACHINE CO., Chicago.—An operating exhibit consisting of two electric sand riddles will be made; represented by T. J. and H. O. Magnuson.

CHASE, FRANK D., Chicago. — Photographs of foundries and other industrial plants built by this engineering firm will be displayed; represented by Frank D. Chase and F. H. Sprague.

CHASE TURBINE MFG. CO., Orange, Mass.—A joint exhibit with the Divine Bros. Co., Utica, N. Y., will be made. The Chase company will display a new automatic polishing and buffing machine and Divine Bros. will show compressed polishing wheels, wheel dressers, balancers, etc.; represented by W. G. Chapman, B. H. Divine and F. W. Sturdevant.

CHICAGO PNEUMATIC TOOL CO., Chicago.—Pneumatic chipping hammers, rammers, hoists, compressors, drills, etc., will be shown.

CHISHOLM - MOORE MFG. CO., Cleveland.—Several types of hoists manufactured by this company will be displayed and an aluminum miniature model hoist will be exhibited showing the inside mechanism.

CINCINNATI PULLEY MACHINERY CO., Cincinnati. — Nine motor-driven, ball-bearing drilling machines of different types and speeds, adapted to the varying conditions of machine shop work will be displayed; represented by J. G. Hey, J. F. Merrieless and C. K. Cairns.

CLARK, CHARLES J., Chicago. — Meters employed for measuring the quantity of blast supplied to cupolas will be displayed and several new instruments also will be shown, which will prove of interest to those now using blast volume meters; represented by Charles J. Clark.

CLEVELAND BLOW PIPE & MFG. CO., Cleveland.—This exhibit will consist of a motor-driven exhaust fan, various designs of hoods for use on buffing, polishing and emery wheels, dust collector and the necessary material required to connect from the emery wheels to the exhaust fan and from the exhaust fan to the dust collector. The fan is used to create a vacuum from the hoods through the necessary pipe and elbows, discharging into the dust collector which removes the dust from the air by centrifugal force. A two-section shower bath for foundry and factory use also will be displayed. Photographs will be exhibited showing sheet metal specialties made by this company for factory use; represented by Edward Coney.

CLEVELAND MILLING MACHINE CO., Cleveland.—A cutter relieving machine, profile grinder, milling machine and a horizontal boring mill will be shown in operation; represented by L. H. Mesker.

CLEVELAND PNEUMATIC TOOL CO., Cleveland.—A complete line of air-operated tools for foundry purposes will be shown in operation. This will include pneumatic tools in all sizes for machine shop work, such as riveting hammers, chipping hammers, etc., sand rammers for foundry use as well as air drills, portable casting grinders, air hose, hose couplings, etc.; represented by H. S. Covey, Arthur Scott, Chas. Garner, G. Gregory and F. E. Schwarze.

COALE, THOMAS E., LUMBER CO., Philadelphia. — A remarkable assortment of white pine and sugar pine pattern lumber in several thicknesses, will be displayed; represented by Thos. E. Coale.

COMBINED SUPPLY & EQUIPMENT CO., Buffalo.—Foundry supplies will be exhibited.

CURTIS PNEUMATIC MACHINERY CO., St. Louis.—The entire exhibit to be made by this company will be operated and will include a vertical double-cylinder single-acting compressor, water-cooled, with a regulating sight feed splash oiling attachment. This compressor will be motor-driven with automatic pressure control and is provided with a circulating pump for cooling water. Hoists and trolleys also will form a part of this display. Pendant vertical cylinder air hoists will be shown as well as a horizontal rope compounded cylinder air hoist, suspended from single I-beam trolleys. Single I-beam hand-operated bridge crane with trolley and a single I-beam bracket jib crane also will be shown; represented by Joseph Macksey.

CUTTER & WOOD SUPPLY CO., Boston. —The large space to be occupied by this company will include the displays of the Chisholm-Moore Mfg. Co., Cleveland, and the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. The Cutter & Wood Supply Co. is the Boston representative of both of these concerns. In addition to the Chisholm-Moore Mfg. Co., the Shepard Electric Crane & Hoist Co., exhibits, an extensive line of tools and supplies employed in metal casting, cleaning, machining, finishing, electro-galvanizing and plating will be displayed; represented by W. S. Wood and Wm. H. Mulholland.

DAILY IRON TRADE AND METAL MARKET REPORT, Cleveland. — This booth will be fitted up as a rest room for visiting foundrymen and free stenographic service will be provided for the exhibitors and visitors; represented by John A. Penton, A. O. Backert, C. J. Stark, H. Cole Estep, J. D. Pease, F. V. Cole, S. H. Jasper, G. O. Hayes, J. F. Ahrens, E. L. Shaner and A. J. Mueller.

DAVIS-BOURNONVILLE CO., Jersey City, N. J.—Oxyacetylene and oxyhydrogen welding and cutting apparatus, acetylene pressure generators, portable outfits, special cutting machines and accessories will be displayed; represented by F. C. Whitney, M. S. Plumley, H. H. Dyar, W. W. Barnes, Alex. Blazer, Geo. Jaeger, G. J. Strobel, F. A. Blood, F. C. Hobbs and G. V. Greene.

DEBEVOISE - ANDERSON CO., INC., New York.—The various brands of bee-hive oven and by-product cokes sold by this company will be displayed, as well as different grades of pig iron, 50 per cent ferrosilicon, limestone and coal; represented by W. Anderson.

DINGS MAGNETIC SEPARATOR CO., Milwaukee.—Four types of power-driven separators will be shown in operation. One of these machines will have a motor attached, another will be provided with a motor generator set, a third will be of the magnetic pulley type with motor and the fourth will be a hand magnet; represented by Messrs. Fobian and Bethke.

DIXON, JOSEPH, CRUCIBLE CO., Jersey City, N. J.—Crucibles, covers, stirrers, stoppers, sand crucibles, scorifiers, cupels, etc., will be displayed; represented by C. A. Johnson, H. C. Sorenson, J. J. Belleville, J. J. Tucker, R. H. Brinkerhoff, C. A. Shaw, E. A. St. John, A. L. Hassis, R. F. Leonard, J. K. Mosen, John A. Condit and H. A. Nealley.

DROUVE, G., Co., Bridgeport, Conn.—An extensive display will be made of samples of puttyless skylight and numerous blueprints and photographs will be shown, illustrating the applications of the sash manufactured by this company.

EASTERN BRASS & INGOT CORP., Waterbury, Conn. — Brass briquette ingots made from various classes of brass chips, brass turnings, etc., will be displayed. The service afforded by this company to producers and consumers of scrap metals consists of converting these finer forms of brass scraps into briquette ingots which are sufficiently solid to withstand commercial handling; represented by Howard Baker, Fred A. Purdy, George G. Hanson and W. S. Lord.

FEDERAL FOUNDRY SUPPLY CO., Cleveland.—An extensive display of molding machines will be made by this company, which will include six different sizes of jolt-ramming machines constructed without valves. When the piston opens the exhaust it automatically shuts-off the intake and the expansion of the air forces the piston the remainder of its travel until the exhaust is fully opened, when the piston drops to the starting point. Six different types of power squeezers and combination jolt and squeezer machines also will be displayed. Extra long cylinders are provided on all squeezers which have extra heavy leather pistons, thereby eliminating the loss of air and effecting economies in air consumption. The plain power squeezers will be shown in two sizes with cylinders 9 and 12 inches in diameter, respectively. Two sizes of the combination jolt-ramming and squeezer machines also will be shown, one having a 9-inch squeezing cylinder and a 4-inch jolting cylinder and the other, a 12-inch squeezing cylinder and 5-inch jolting cylinder. These machines are built both stationary and portable. Four sizes of electric vibrators and knee switches, portable and stationary core ovens provided with swinging doors, also will be shown, as well as samples of plumbago, parting compound, steel cement, wax vent wire, etc., represented by Ralph Ditty, Walter J. Adams, I. D. Adams, Ellsworth Kaye, W. J. Smith and John Bayer.

FELT & TARRANT MFG. CO., Chicago. —The adding and calculating machines manufactured by this company will be displayed and demonstrations in their application to inventory, payroll, cost work, billing, etc., will be made; represented by William F. Sims.

FORBES & MYERS, Worcester, Mass.—Polishing and buffing machines will be displayed.

FOREIGN CRUCIBLES CORP., LTD., New York.—Samples of the imported graphite crucibles sold by this company will be shown; represented by Geo. H. Ames.

FOUNDRY EQUIPMENT CO., Cleveland. —Core and mold ovens, core cars, melting furnaces, oil burners, etc., will be displayed; represented by F. A. Coleman and C. A. Barnett.

The Foundry, Cleveland. — This booth will be fitted up as a rest room for visiting foundrymen and free stenographic service will be provided for the exhibitors and visitors; represented by John A. Penton, A. O. Backert, C. J. Stark, H. Cole Estep, J. D. Pease, F. V. Cole, S. H. Jasper, G. O. Hayes, J. F. Ahrens, E. L. Shaner, and A. J. Mueller.

GARDNER MACHINE CO., Beloit, Wis. —Belt and motor-driven disc grinders, as well as samples of work done on disc-grinding machines will be exhibited.

GENERAL ELECTRIC CO., Schenectady, N. Y.—One of the features of this exhibit will be an electrically-operated core oven furnished by the Oven Equipment Co., New Haven, Conn. It will be equipped with six General Electric heating units operating at a maximum capacity of 21 kilowatts, and arranged for service on a 220-volt, 60-cycle, 3-phase, alternating current circuit. The other equipment includes a control panel, a mercury-actuated thermostat and a recording thermometer. The oven will be heated to an average of 350 to 500 degrees Fahr. In addition, a centrifugal air compressor for furnishing blast to cupolas will be displayed. These compressors now are widely used and are particularly adapted for cupola service because of the non-pulsating character of the blast, with motor or turbine drive. Operating with a direct current motor the drive pressure is regulated by changing the speed of the set by motor field rheostat. For induction motors arranged for constant speed and pressure, the blast is regulated in place of the motor; represented by J. M. Hollister, M. R. Griffith, A. R. Bush, W. C. Fish, C. B. Davis, J. F. Steele and D. G. Brokaw.

GENERAL FIRE EXTINGUISHER CO., Providence, R. I.—The automatic sprinkler system built by this company will be installed in a wire-glass house for the purpose of demonstrating its methods of operation and that of the American District Telegraph supervisory system. Motion pictures also will be shown several times daily featuring the operation of this system and the Grinnell automatic sprinkler head which forms an important part of it. A method of gas heating for domestic and industrial purposes also will be demonstrated; represented by W. A. Kennedy, A. J. Richmond, R. A. Jenckes, J. D. Pryor, George S. Barrows and Carl Hausler Hale.

GOLDSCHMIDT THERMIT CO., New York.—A large weld on a crank shaft made by the thermit process will be exhibited, as well as a complete line of samples of all of the carbon-free metals and alloys made by this company including tungsten, chromium-manganese, ferro - chromium, ferro - tungsten, manganese-copper, cobalt, etc.; represented by Arthur F. Braid, H. G. Spilsbury, J. G. McCarty, W. R. Hulbert and H. D. Kelley.

GREAT WESTERN MFG. CO., Leavenworth, Kans.—Three types of gyratory foundry riddles, as well as a new riddle designed for bench work will be shown; represented by F. A. Pickett and George W. Combs.

HARRISON SUPPLY CO., Boston.—Metallic sand-blast abrasives will be exhibited, including chilled shot and crushed shot for sand-blast purposes; represented by Nathan C. Harrison, J. Henry Duclos Jr., Charles R. Dawson, B. L. Snow and E. E. Ricker.

HAUCK MFG. CO., Brooklyn, N. Y.—Cupola lighters, mold dryers, ladle and rivet heaters, torches and forges will be exhibited; represented by A. E. Hauck, Busch Hauck and A. P. Link.

HAYWARD CO., New York.—Photographs of the equipment built by this company for handling various materials with different kinds of hoisting apparatus will be exhibited; represented by H. M. Davison and C. F. Hutchings.

HERMAN PNEUMATIC MACHINE CO., Pittsburgh. — A plain jar-ramming molding machine and a combination jar-ramming and squeezer machine will be exhibited, but will not be operated; represented by Thos. Kaveny, H. T. Frauenheim, A. M. Frauenheim, Alfred Herman, Robt. F. Ringle, I. J. Oesterling, R. P. Morgan, Walter Hughes, A. McWithey, Robt. Porteous and Harry W. Gahan.

HILL, CLARKE & CO., Boston.—The extensive display of machine tools to be made by this company will be operated.

HOEVEL MFG. CORP., New York. — A rotary table sand-blast machine and a revolving barrel sand-blast machine, built by this company, will be shown in operation; represented by H. F. Hoevel, F. W. Weiss, L. B. Passmore and G. H. Seltzer.

HOLZ, HERMAN A., New York City.—A portable apparatus for determining the hardness of metals will be shown.

INTERNATIONAL MOLDING MACHINE CO., Chicago.—Electric and air jar-ramming molding machines, power squeezers, combination jolt squeezers, combination stripping squeezers, hand turn-over pattern-drawing machines, power turn-over power pattern-drawing machines, combination jar-ramming machines of the turn-over pattern drawing, power turnover foot pattern-drawing and power turn-over power pattern-drawing types, as well as stripping plate machines will be exhibited; represented by Edward A. Pridmore, W. W. Miller, F. W. Hamel and J. L. Lanigan.

THE IRON TRADE REVIEW, Cleveland. —This booth will be fitted up as a rest room for visiting foundrymen and free stenographic service will be provided for the exhibitors and visitors; represented by John A. Penton, A. O. Backert, C. J. Stark, H. Cole Estep, J. D. Pease, F. V. Cole, S. H. Jasper, G. O. Hayes, J. F. Ahrens, E. L. Shaner and A. J. Mueller.

JENNISON-WRIGHT CO., Toledo, O.—Creosoted wood blocks for factory floors will be displayed; represented by H. G. Jennison, Lloyd P. Drinker and Frank B. Goodman.

KELLOGG, SPENCER & SONS, INC., Buffalo.—Liquid core binders and pure linseed oil will be exhibited; represented by A. P. Mason, W. L. Goetz and R. C. Boggess.

KELLY, T. P., & CO., INC., New York. —The exhibit space reserved by this company will be arranged as an office and rest room for the convenience of the large number of friends of this concern; represented by H. F. Maurel, B. H. Forman, F. J. Rohe, H. J. Winters, V. C. Smith and W. F. Kaine.

KING, JULIUS, OPTICAL CO., New York. Safety goggles, helmets and safety appliances will be exhibited; represented by W. G. King, F. W. King, A. G. Larson, and J. J. Duffy.

LAMSON CO., Boston.—Conveyors of various types for foundry and general industrial use will be displayed. These include a gravity roller conveyor for handling pig iron, cores, etc., a parcel overhead carrier for carrying cores and other material from one foundry department to another, etc. All of the labor-saving and time-saving devices built by this company will be demonstrated by full size models and by photographs of installations. The American Pneumatic Service Co., which controls the 8-inch postal tubes operated in five cities of the country, will co-operate with the Lamson Co. in making this exhibit; represented by Fred B. Barton.

LEES-BRADNER CO., Cleveland.—A machine tool exhibit will be made by this company under the direction of its Boston agent, the Lynd-Farquhar Co. The exhibit will consist of a standard thread miller and a gear generator; represented by E. A. Bayton.

LEWIS-SHEPARD CO., Boston.—Elevating trucks which make possible the system of handling goods on platforms will be displayed; represented by A. L. Lewis, J. W. Adams and E. E. Wallace.

LUPTON'S, DAVID, SONS CO., Philadelphia.—Models of the rolled steel products for light and ventilation manufactured by this company, will be shown and detailed drawings as well as photographs of installations will be on display; represented by Clarke P. Pond, C. F. P. Buckwalter and H. R. Wilkinson.

LYND-FARQUHAR CO., Boston.—A 26-inch combined open side crank planer and shaper will be exhibited in operation. This is a new combination machine embodying all of the features of a planer with the quick motion of the shaper. In addition, a Lees-Bradner gear generating machine and a thread milling machine will be exhibited in operation; represented by Ralph Streeter, Howard L. Rich, John S. Alcorn and E. A. Bayden.

MAHR MFG. CO., Minneapolis.—Foundry torches for cupola lighting, mold drying, preheating, etc., will be shown, as well as melting, rivet and forging furnaces; represented by J. A. Mueller, J. R. Matthews, R. B. Ecker, J. A. Mahr and H. H. Warner.

MALLEABLE IRON FITTINGS CO., Branford, Conn.—The complete line of vibrators, sizes ⅜ to 2 inches, inclusive, mounted for demonstration purposes will be shown, as well as the complete line of vibrator accessories made by this company, including knee valves, blow guns, starting valves, hose clamps, etc.; represented by G. B. Pickop and J. C. Page.

McCORMICK, J. S., CO., Pittsburgh.—A complete line of foundry supplies and facings will be shown as well as large cores coated with the blacking manufactured by this company; represented by J. S. McCormick, T. E. Malone, S. R. Costley and A. T. Richardson.

McCROSKY REAMER CO., Meadville, Pa.—A complete line of adjustable reamers, quick-change chucks and collets for drilling, tapping, stud-setting, etc., will be exhibited as well as turret tool posts for lathes, tap and die holders for turret lathes, universal lamp brackets and other time-saving devices for the machine shop; represented by C. M. Sutton and Clyde Derby.

McLAIN'S SYSTEM, INC., Milwaukee.—Samples of semi-steel castings of light section, such as automobile cylinders, pistons and other castings containing from 20 to 50 per cent steel, made by McLain graduates, will be displayed. Open-hearth steel castings poured from metal made in a McLain-Carter oil-fired furnace, also will be shown; represented by David McLain, I. V. Scanlan and Carl Huebl.

MICHIGAN SMELTING & REFINING Co., Detroit.—Ingot brass, bronze, tin and lead products including lead pipe, solders, babbitt and type metals will be displayed; represented by Joseph Stillman, Henry Levitt, Wm. J. Schweitzer, James Tiernan, E. E. Berliner, H. D. LeBel, R. H. Evans, R. R. Arnold and R. E. Moore.

MIDLAND MACHINE CO., Detroit.—All of the molding machines to be shown by this company will be operated and will include a small jar-ramming roll-over machine; hand-rammed roll-over machine and a small jar-ramming roll-over machine for making cores, designed for light operation by women in the core room if necessary. Motion pictures of the machines in operation in various plants will form a feature of this exhibit; represented by Geo. L. Grimes, L. V. Grimes, C. R. Jones and Oswald Carliss.

MOLTRUP STEEL PRODUCTS CO., Beaver Falls, Pa.—An extensive display will be made of flattened steel pattern plates, core plates, finished machine keys, finished machine rack and cold drawn steel bars; represented by N. S. Leyda and F. H. Guppy.

MONARCH ENGINEERING & MFG. CO., Baltimore, Md.—Types of the various line of foundry equipment, manufactured by this company will be exhibited, including several core ovens, showing the application of gas, oil, coal and coke as fuel and each oven will be of a different type designed to meet the requirements of various foundry conditions. Several crucible furnaces, designed for the use of gas, oil, coal and coke as fuel for the melting of non-ferrous metals, single and double chamber furnaces for melting metals without the aid of a crucible, oil and gas-fired annealing, tempering and hardening furnaces and in addition several auxiliary units which enter into general foundry equipment will be shown; represented by H. D. Harvey, James J. Allen, H. W. Raber, M. W. Woodburn and Frank Maujean.

MOTT SAND-BLAST MFG. CO., INC., Brooklyn, N. Y.—An operating exhibit consisting of a sand-blast tumbling barrel, hose-type machine, cabinet, exhausters, accessories, etc., will be made; represented by Davis Mayer, Louis Schroeder, C. B. Schneible, E. J. Rosenthal, Foster J. Hull, and E. C. Gilmour.

MUMFORD, E. H., CO., Elizabeth, N. J.—Samples of the line of molding machines manufactured by this company will be displayed; represented by T. J. Mumford, H. W. Sinclair and J. A. Walsh.

MUMFORD MOLDING MACHINE CO., Chicago.—Several of the different types of molding machines built by this company will be displayed and, in addition, enlarged cross-sectional drawings of the company's latest design of molding machine will be shown; represented by Donald Alexander, Otto F. Weiss, James T. Lee and W. H. Huelster.

NATIONAL ENGINEERING CO., Chicago.—An intensive sand mixer for foundry use will be shown in operation and literature will be distributed, describing a continuous core reducer and a screen separator; represented by H. S. Simpson.

NEW ENGLAND COAL & COKE CO., Boston.—A model of Bunker Hill monument will be reproduced from by-product coke. This replica will have a height of 45 feet, the base of which will be decorated with statuary and potted plants. Festoons of colored electric lights will be strung from the peak of the monument to each of the four standard-bearers on the four corners. Four statues, about 8 feet high, will surround the monument showing typical New England Puritans in the costumes of their time; represented by W. J. Lavelle, F. C. Knight, J. M. Dunbar and J. M. Taylor.

NEW HAVEN SAND-BLAST CO., New Haven, Conn.—A sand-blast rolling barrel and a medium size hose-type, sand-blast machine will be exhibited, as well as chilled shot, diamond grit, etc.; represented by C. A. Dreisback, C. E. Billings and C. S. Johnson.

NICHOLLS, WM. H., CO., INC., Brooklyn, N. Y.—Two combination jolt-ramming and power squeezers with automatic gravity drawing device will be exhibited, in addition to a plain power molding machine, a plain combination jolt-ramming and power molding machine and a combination jolt-ramming and power molding machine with roll-over device; represented by Wm. H. Nicholls.

NORMA COMPANY OF AMERICA, New York.—Ball bearings, roller bearings, precision testing instruments, etc., will be displayed; represented by E. A. Perkins.

NORTON CO., Worcester, Mass. — Four grinding machines will be shown in operation and these will be of the bench and floor types usually employed in foundries and provided with protection hoods. Grinding wheels used in foundry work also will be displayed; represented by George C. Montague, W. G. Snow, Herbert Duckworth and Wallace T. Montague.

OBERMAYER, S., CO., Chicago.—A full line of tumbling barrels, brass furnaces and other equipment and supplies for iron and brass foundries will be shown; represented by S. T. Johnson, E. D. Frohman, William Fenton, Wm. Fitzpatrick Sr., Wm. Fitzpatrick Jr., J. J. McDevitt, O. J. Peterson and George Deyette.

OLIVER MACHINERY CO., Grand Rapids, Mich.—A 16-inch tool room engine lathe will be exhibited in operation and in addition photographs will be shown of the complete line of pattern shop machinery and the universal wood milling machine built by this company; represented by J. W. Oliver, A. Blake, G. W. Crosley, A. S. Kurkjian and J. R. Duthie.

OSBORN MFG. CO., Cleveland.—The complete line of hand and power-operated molding machines manufactured by this company will be displayed; represented by H. R. Atwater, E. T. Doddridge, E. W. Jacobi, J. C. Alberts and E. J. Byerlein.

OXWELD ACETYLENE CO., Newark, N. J.—A complete line of oxweld equipment, part of which will be shown in operation, will be on display. This will include oxweld equipment of a low pressure type, an acetylene generating unit, and oxweld portable pressure generator in operation and welding and cutting blow pipes in representative applications, as made by oxweld users in New England and vicinity.

PANGBORN CORPORATION, Hagerstown, Md.—Photographs of various models and types of sand-blast and allied equipment, as well as samples of work done by these machines will be displayed in the booths fitted up by this company as a rest and reception room where telephone and stenographic service will be provided; represented by Thomas W. Pangborn, John C. Pangborn, W. C. Lytle, P. J. Potter, George A. Cooley, Alfred L. Holmes and C. M. Goldman.

PAXSON, J. W., CO., Philadelphia.—An extensive line of foundry equipment and supplies will be exhibited, including sands, facings, sand-blast machinery, etc. Photographs and blue prints also will be displayed showing the various lines of foundry equipment built by this company; represented by H. M. Bougher, W. S. Thomas, R. H. Rehm, E. M. Taggart, A. G. Warren and I. F. Kremer.

PICKANDS, BROWN & CO., Chicago.—A patriotically-trimmed display of Solvay coke in the form of a wheel hub with gilded wooden spokes wil be made; represented by Geo. A. T. Long, Thos. W. Glasscot, Bayard T. Bacon, Jas. A. Galligan, Jas. A. Ballard and Wm. H. Ball.

PITTSBURGH CRUSHED STEEL CO., Pittsburgh.—Samples of all sizes of angular grit used for sand-blast purposes will be exhibited; represented by G. H. Kann.

PORTAGE SILICA CO., Youngstown, O.—Samples of the silica sand, gravel and sand-blast sand, mined and prepared by this company, will be displayed, as well as the original rock from which this material is obtained. Photographs of this company's extensive plant also will be shown; represented by E. E. Klooz and L. R. Farrell.

PRICE, THORNTON W., Woolworth building, New York.—A model of the Ludlum electric furnace with samples of tool steel, pig iron, washed metal, iron and steel castings, etc., poured from metal made in this furnace will be exhibited. All of this material is being manufactured on a commercial scale by the Sweetser Bainbridge Metal Alloys Corp., which has several Ludlum electric furnaces in operation. Large photographs of this furnace also will be shown, together with analyses of these various products; represented by Thornton W. Price, G. E. Munro and O. D. Conover.

PRIDMORE, HENRY E., INC., Chicago.—The regular line of molding machines manufactured by this company will be shown and several new features will be introduced; represented by Charles H. Ellis, D. F. Eagan, A. V. Magnuson and J. W. Dopp.

QUIGLEY FURNACE SPECIALTIES CO., New York City.—A binding material used for furnace linings will be displayed.

RICHEY, BROWNE & DONALD, Maspeth, N. Y.—Roller-ramming molding machines and sand handling appliances will be exhibited; represented by Walter Hofmann and Joseph B. Donahue.

RIVETT LATHE & GRINDER CO., Boston.—A back-geared precision bench lathe mounted on a cabinet with individual motor drive and attachments will be exhibited, together with two sizes of internal grinders complete with standard equipment. An improved threading tool also will be displayed; represented by Cecil Ogden, A. O. Richter, Fred Lord and F. H. Halstead.

ROBESON PROCESS CO., New York.—Cores made with glutrin and samples of that material will be shown, as well as some interesting photographs. The booth will be fitted up as a reception room and a useful souvenir will be distributed; represented by Geo. N. Moore, T. J. Ryan and R. S. Hughes.

ROGERS, BROWN & CO., Cincinnati.—An extensive display will be made of samples of pig iron representative of practically every grade manufactured by blast furnaces in the United States. Bee-hive and by-product cokes also will be shown, as well as an extensive assortment of ferro-alloys. Gray iron, semisteel and malleable iron castings, both ornamental and practical will be exhibited; represented by A. A. Fowler, W. T. Shepard, E. L. Billingslea, Geo. R. Sullivan, Richard Peters Jr., R. W. Clark, Otto Arlt, J. A. Claussen, Sterling W. Hubbard, Thos. E. Wilson, F. J. Waldo, A. T. Stengel, J. C. Mears, H. W. Fernald, F. E. Fitts, W. R. Maher, E. F. Bowden, F. W. Miller and F. W. Bauer.

SAND MIXING MACHINE CO., New York.—This exhibit will consist of a sand cutting machine; rotary table sand-blast room; humane sand-blast rotary table in which the operator stands outside and is immune from dust; large sand-blast tumbling barrel and a new type of humane sand-blast room for handling all kinds of small work; represented by V. E. Minich, H. L. Wadsworth, Hutton H. Haley, J. D. Alexander and Charles G. Smith.

SHEPARD ELECTRIC CRANE & HOIST CO., Montour Falls, N. Y.—Standard hoists built by this company will be displayed, including a foundry hoist, having variable speed control; a new light load capacity hoist, designed to take care of loads slightly too heavy for one man to handle; an electric hoist which is portable and applicable to cranes and derricks, and an enclosed electric winch, which operates in oil. In addition to the foregoing, a section of monorail track and T-bar conductor with insulators and accessories will be displayed. A set of enlarged photographs showing the entire Shepard line will be included in this exhibit; represented by F. A. Hatch, A. J. Barnes, R. H. McGredy, W. A. Battey, W. C. Briggs, W. B. Martwick, N. P. Farrar and H. W. Gledhill.

SIMONDS MFG. CO., Fitchburg, Mass.—Saws for cutting metals will be shown.

SLY, W. W., MFG. CO., Cleveland.—An extensive display of equipment for cleaning castings will be made, including a 10 x 10-foot sand-blast room, horizontal sand-blast barrel, sand-blast pressure tank and a sand-blast mill with dust arrester. In addition, a rosin mill and a two-section drawer type core oven will be displayed; represented by W. C. Sly, Geo. J. Fanner, P. W. Graue and H. P. Furlong.

SMITH, R. P., & SONS CO., Chicago.—Safety shoes for molders and foundrymen will be displayed; represented by J. B. Smith Jr.

SMITH, WERNER G., Co., Cleveland.—Core oils, cores made from these oils and castings in which cores have been used made from these core oils, will be displayed. In addition an extensive exhibit will be made of different grades of plumbago facings; represented by Werner G. Smith, Frank H. Dodge, Milton S. Fiuley, Albert L. Fay, L. P. Robinson, W. E. Rayel and Louis F. Ferster.

STANDARD EQUIPMENT CO., New Haven, Conn.—A water cinder mill will be shown in operation; represented by Chas. A. Dreisbach and Louis Bradley.

STERLING WHEELBARROW CO., West Allis, Wis.—In addition to having its booth fitted up as a rest-room for the convenience of visiting foundrymen, it will exhibit its line of steel flasks, foundry wheelbarrows and foundry specialties such as wedges, skim gates, etc.; represented by I. R. Smith, H. H. Baker, J. M. Dickson, Geo. H. Lambkin, Edw. Dowd, J. W. Dopp, J. J. Coyne and Chas. L. Kirk.

STRONG-KENNARD & NUTT CO., Cleveland.—A general line of safety devices will be shown, including goggles fitted with non-splintering glass, respirators, leather asbestos leggings and gloves, safety signs, first aid cabinets, hospital furnishings and equipments, fire extinguishers, sand-blast, dust helmets and many other safety supplies. The non-splintering glass used in the goggles is made by putting together two pieces of glass and welding them with material similar to celluloid. In appearance, the lenses are the same as the ordinary goggle lenses, but the advantage of their use is, that even though cracked, they will not splinter owing to the interlining which holds all the chips; represented by Buell W. Nutt and Walter Marken.

SULLIVAN MACHINERY CO., Chicago.—An angle-compound compressor, 14 x 8¾ x 10 inches, equipped with improved plate valves throughout will be installed, which will supply air for the operating exhibits in the foundry machinery and machine tool sections. This machine will be driven by a 75-horsepower General Electric motor. Its capacity at 250 revolutions per minute is 445 cubic feet of free air against a terminal pressure of 100 pounds per square inch. In addition, plate valves of the end-rolling finger pattern will be shown. An 8 x 8-inch, belt-driven, single stage compressor, of the splash-oiled, totally-enclosed type will be exhibited in addition to air lift pumps and an air booster for securing water supply from wells. A photographic exhibit also will be made of other classes of Sullivan air compressors; represented by G. E. Wolcott, H. C. O'Brien, G. H. Richey and Alexander Milne.

THOMAS IRON CO., Boston.—Samples of the various grades of pig iron manufactured by this company will be shown.

TITANIUM ALLOY MFG. CO., Niagara Falls, N. Y.—Ferro-carbon-titanium manufactured by this company will be exhibited and in addition there will be held a display of castings manufactured by the Titanium Bronze Co., of Niagara Falls, allied with the parent company. The Titanium Alloy Mfg. Co. will be represented by G. A. White, Wm. J. Evans and Wm. V. Knowles. The Titanium Bronze Co. will be represented by H. R. Corse and A. C. Olfs.

UNITED COMPOUND CO., Buffalo.—Wax wire for venting cores and wax for use on patterns will be displayed; represented by John W. Bradley and L. F. Leney.

UNITED METAL HOSE CO., New York City.—Flexible metal hose of various types will be exhibited, including armored metal, lined, welding, air, pneumatic tool, metal armored sand-blast, metal hose for steam, and metal-lined hose for oil; represented by Joseph M. Lewin.

UNITED STATES GRAPHITE CO., Saginaw, Mich.—Samples of graphite foundry facings will be displayed; represented by A. W. Walker, J. G. Drought, R. A. Corrigan, F. B. Godard and H. F. Gump.

U. S. MOLDING MACHINE CO., Cleveland.—Six different types of molding machines, manufactured by this company will be shown in operation, including a plain air squeezer, combination jar-ramming and squeezer molding machine, combination jar-ramming, squeezer and pattern-drawing machine, combination jar-ramming and pattern-drawing machine, combination jar-ramming roll-over and pattern-drawing machine and a plain air-operated jar-ramming machine; represented by J. N., C. F. and J. L. Battenfeld.

UNITED STATES SILICA CO., Chicago.—Samples of the flint shot made by this company will be exhibited. Photographs of plants where this material is produced as well as photographs of customers' plants and product will be shown in addition to the photograph of this company's new plant; represented by A. Volney Foster, Lewis B. Reed, Harry F. Goebig, and Oliver Cook.

WALLACE, J. D., & CO., Chicago.—A bench planer will be shown in operation, equipped with a special flap and shutter safety guard; represented by J. D. Wallace.

WARNER & SWASEY CO., Cleveland.—The machine tool exhibit that will be made by this company will consist of a universal hollow hexagon turret lathe, operating on bar work; a universal turret screw machine, operating on bar work. and a plain head turret screw machine. All of this equipment will be motor-driven; represented by A. C. Cook and H. L. Kinsley.

WHEELER & HOLCOMB CO., Chicago.—A display will be made of "safety first" wearing apparel, including gloves and mittens made from asbestos cloth and leather. Leggings will be shown made of asbestos cloth, fireproofed duck cloth and chrome leather. In addition, aprons will be shown, made of asbestos cloth and fireproofed duck, as well as spats, short leggins, hip leggins, suits, hand leathers and other apparel for protecting foundry and steel works operators; represented by F. H. Wheeler and Charles A. Kingsbury.

WHITE & BRO., INC., Philadelphia.—Ingot metals of all kinds will be shown including the company's two brands of copper ingots, as well as castings made from these ingots; represented by Frank Krug.

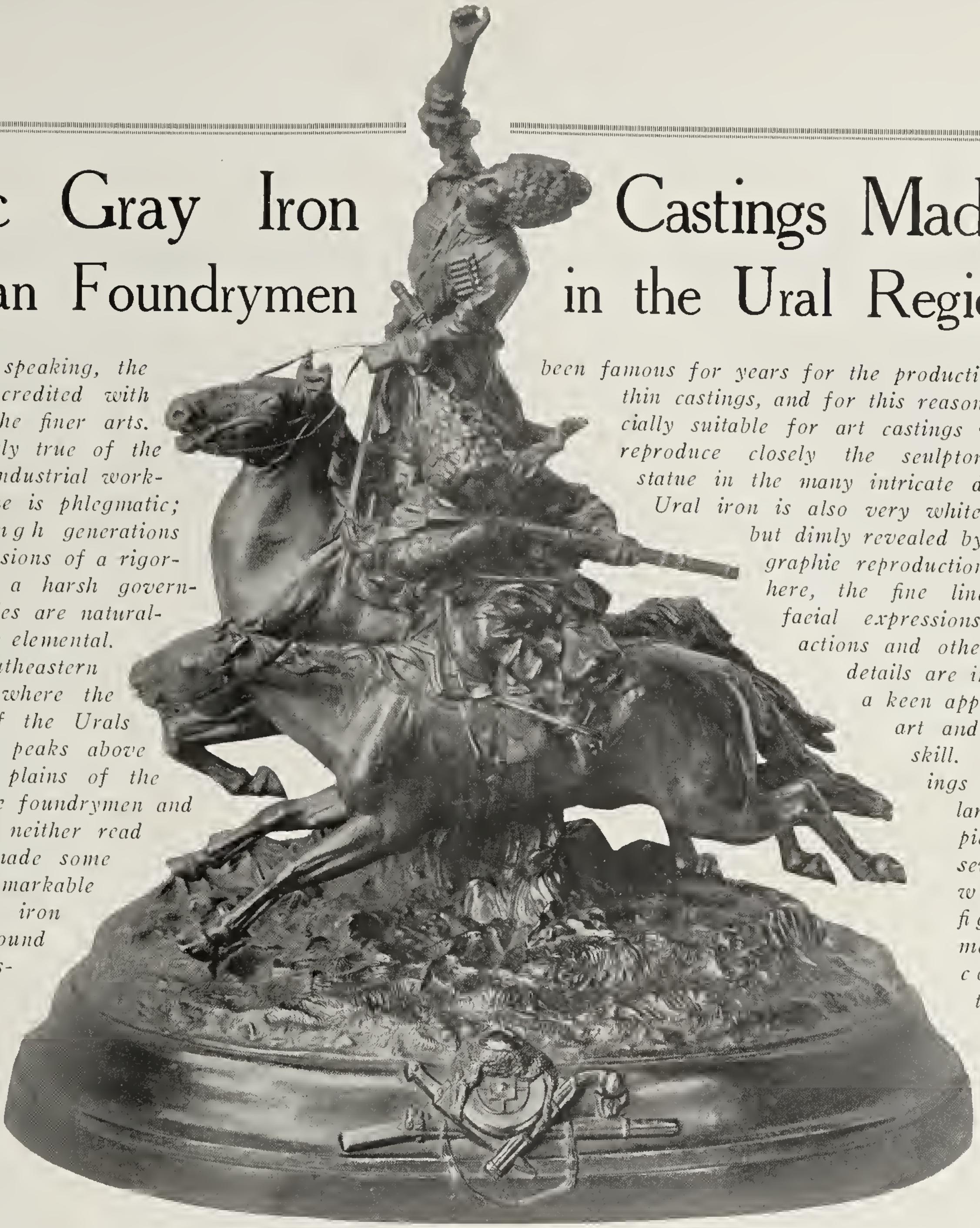
WHITEHEAD BROTHERS CO., Providence, R. I.—The booth to be occupied by this company will be fitted up as an office and rest room for the reception of friends of this concern; represented by A. J. Miller, J. H. Whitehead, V. L. Whitehead and Charles E. Andrews.

WHITING FOUNDRY EQUIPMENT CO., Harvey, Ill.—The foundry equipment that will be displayed includes a 10-ton crane trolley, a teapot spout ladle and a round plate barrel tumbler. In addition, photographs and drawings of the extensive line of foundry machinery manufactured by this company will be exhibited; represented by R. H. Bourne and C. A. Hardy.

WOODISON, E. J., CO., Detroit.—An extensive display of foundry equipment and supplies will be made, including an electrically-operated jolt-ramming roll-over molding machine, wood grinder, core oils, buffing compositions, etc.; represented by E. J. Woodison, D. H. Woodison, G. A. Burman, U. W. Frink, W. J. Wark, W. M. Maybank, W. Renchie, D. D. Baxter, H. T. Taylor, C. G. Howe, G. Brady and C. J. Skeffington.

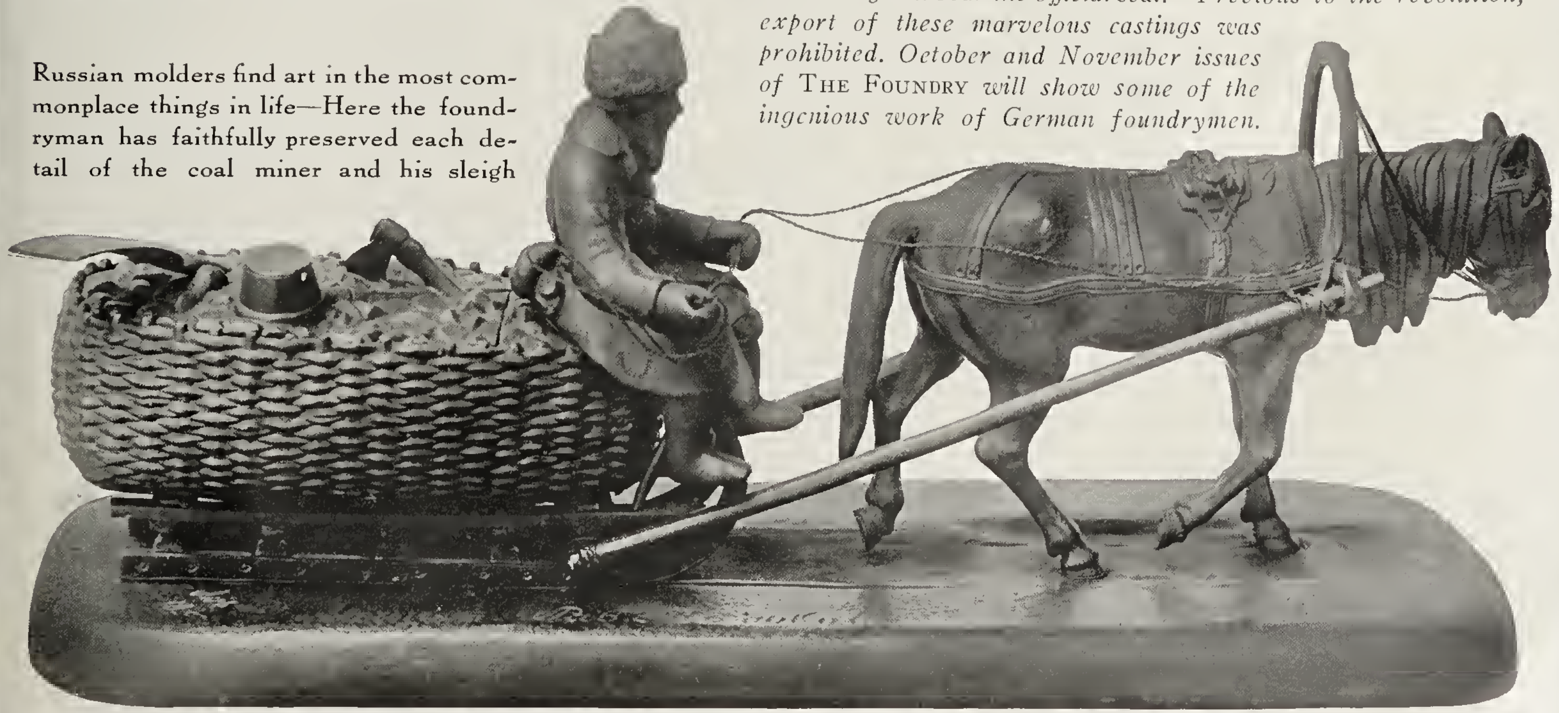
WOOD'S, T. B., SONS CO., Chambersburg, Pa.—Tapered snap flasks and automatic adjustable snap jackets will be exhibited as well as flasks in various sizes fitted with pin equipment, designed for the different methods of snap molding. Jackets in corresponding sizes also will be displayed adapted for a wide range of snap flask work; represented by Chas. M. Wood, Geo. M. Naylor and Victor Lesher.

Artistic Gray Iron Castings Made by Russian Foundrymen in the Ural Regions



The Cossacks on Horseback—This gray iron reproduction of a famous statue in Moscow is a masterpiece by the Ural foundrymen—The finish closely resembles polished bronze

GENERALLY speaking, the Russian is credited with little taste for the finer arts. This is particularly true of the lower castes of industrial workers. By nature he is phlegmatic; struggling through generations against the oppressions of a rigorous climate and a harsh government, his tendencies are naturally bent toward the elemental. Yet in the southeastern part of Russia, where the rugged ranges of the Urals push their rocky peaks above the more fertile plains of the Steppes, the native foundrymen and molders who can neither read nor write have made some of the most remarkable and artistic gray iron castings to be found in the world. Illustrations on this and the three following pages show a number of Russian castings taken from the private collection of John A. Penton, of Cleveland. Most of the smaller views represent the actual size of the castings. Several of the views, however, illustrate castings which are 12 and 14 inches high and proportionately wide. High phosphorus iron made in the Ural regions has been famous for years for the production of light, thin castings, and for this reason it is especially suitable for art castings which must reproduce closely the sculptor's original statue in the many intricate details. The Ural iron is also very white. Although but dimly revealed by the photographic reproduction illustrated here, the fine lines showing facial expressions, muscular actions and other important details are indicative of a keen appreciation of art and wonderful skill. The castings are made largely in one piece, but in several cases where the figures are more or less complicated, the foundrymen had to resort to the expedient of casting the component parts individually. The accuracy of the work is so remarkable that it is almost impossible to ascertain where the several parts are joined. The foundries where these art pieces are made are under government control and the castings all bear the official seal. Previous to the revolution, export of these marvelous castings was prohibited. October and November issues of The Foundry *will show some of the ingenious work of German foundrymen.*



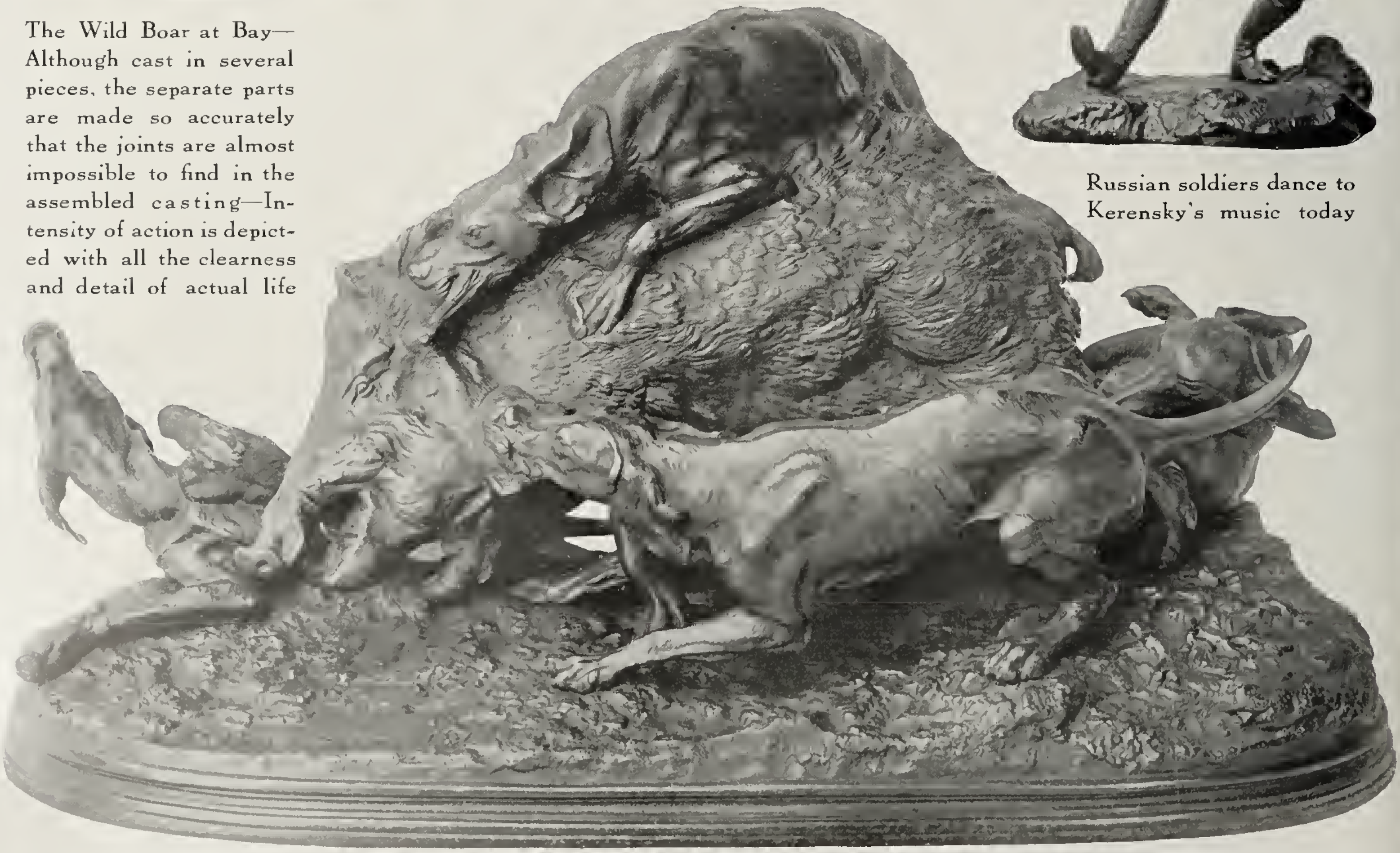
Russian molders find art in the most commonplace things in life—Here the foundryman has faithfully preserved each detail of the coal miner and his sleigh

Diana — the Virgin Huntress—True in every detail of poise and expression to the artist's original

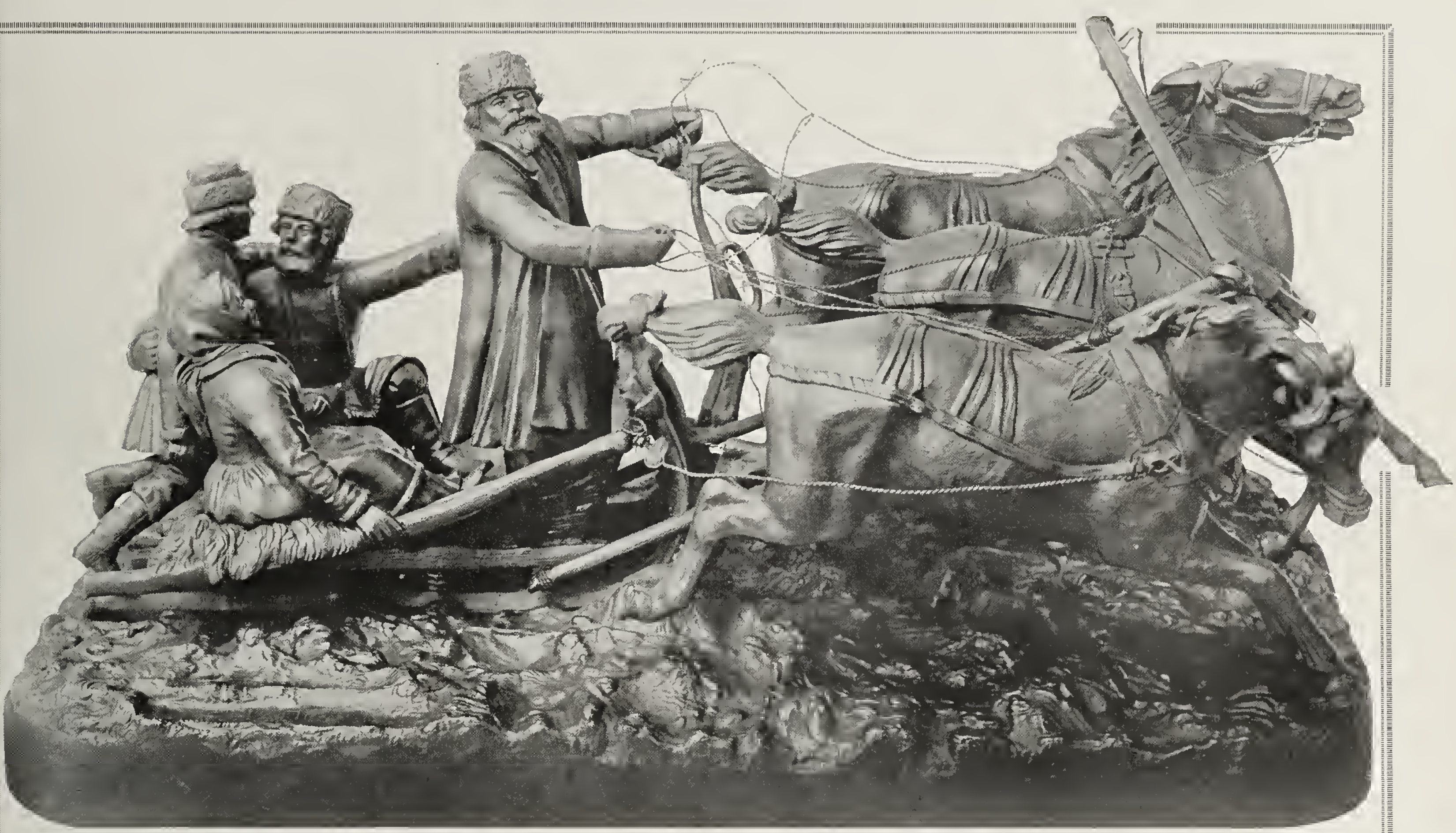
Bench Molder—Even the illiterate and phlegmatic Russian appreciates the existence of art in industry—Simple tools suit his purpose

Three Niebelungen Dwarfs—Symbolical of the characters of an old legend

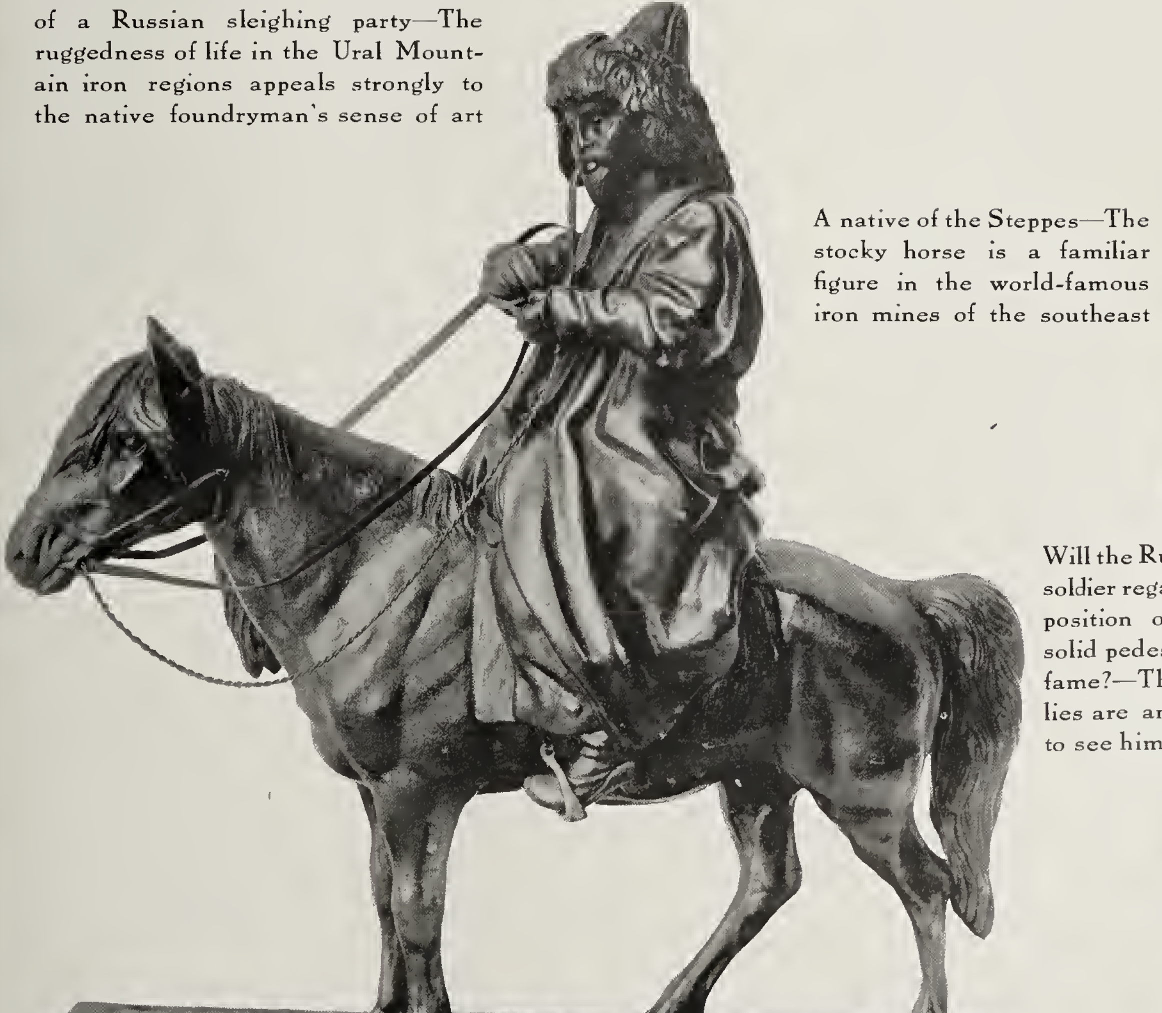
Russian soldiers dance to Kerensky's music today



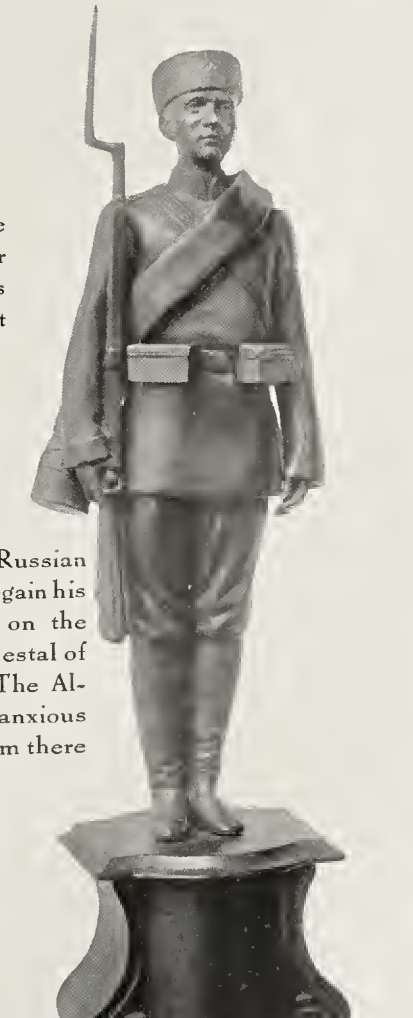
The Wild Boar at Bay—Although cast in several pieces, the separate parts are made so accurately that the joints are almost impossible to find in the assembled casting—Intensity of action is depicted with all the clearness and detail of actual life



All the amazing skill and dexterity of the molder are shown in this casting of a Russian sleighing party—The ruggedness of life in the Ural Mountain iron regions appeals strongly to the native foundryman's sense of art



A native of the Steppes—The stocky horse is a familiar figure in the world-famous iron mines of the southeast



Will the Russian soldier regain his position on the solid pedestal of fame?—The Allies are anxious to see him there

Capable of hitting the mark; but is he aiming east or west?

The native Russian is a keen lover of animal life—The position and muscles of the hunting dog show that he is rapidly running his quarry to earth

Cub Bear at Play

The actual casting is no bigger than this view but every detail stands out prominently

After the Partridge—The dog in the foreground is the same one shown at the top of the page—His companion seems to be pursuing a policy of watchful waiting—This casting is another proof of the artisan's appreciation of nature and outdoor sports

Molding and Coring a 5-Ton Gear Cutter Bed

How One Foundry Rigged-Up for Work for Which the Plant Was Not Designed and How Satisfactory Results Were Obtained

By Wm J Kihn

UNDER present industrial conditions, with shops designed for one line of work taking on other classes, and with capacity crowded to the limit, any methods which tend to increase the tonnage per unit of floor space, without extensive additions or changes, are of great value. As an example of what can be done a description of some of the methods practiced at the Gurney Electric Elevator Works, Honesdale, Pa., will be of interest.

Originally the foundry was designed to handle elevator work exclusively, but it now is handling also a line of machine tools in addition to its regular work. The foundry is equipped with one 10-ton crane and has a melting capacity of 7 tons per hour.

A short time ago the foundry was called upon to make the castings for a number of 96-inch gear cutters. The beds of these machines, with which the present article deals, weighed 10,300 pounds and required 11,000 pounds of cores per casting. The overall length of each bed was 13 feet 9 inches.

Two molders and a helper rammed-up the job in two days, 36 hours having been allowed to skin-dry the bed and 1½ days were consumed in covering-up and getting ready to cast. Beginning Monday, therefore, the job was ready to cast Friday afternoon. A large amount of dry sand work having been necessary, however, it was possible to cast only every other day, and consequently, the first casting was poured on Saturday.

Difficulties Overcome

It was necessary to get one casting per week and to do this under these circumstances meant two pits, with the resultant duplication of rigging and the tying-up of a large amount of valuable floor space, or shaking-out the casting on Monday and preparing the pit for work on Tuesday.

However, shaking-out this particular casting in such a short time presented difficulties, due to the fact that it was not permissible to hold down the five body cores, *A, B, C, D,* and *E,* Figs. 1 and 3, with chaplets, as the base or bottom of the casting, which was made in the cope, had to be oil-tight. This necessitated bolting these five cores to a frame in the bottom of the pit, and, as the tops of the cores when placed in the mold, were inaccessible after casting, a method of release for the cores from the bottom of the pit, that would be quick and positive had to be devised.

Fig. 2 shows the pit frame in place. It has machined lugs on the sides for straight edges, and a number of lugs in the center which have holes cored through them taking a 1-inch rod to which a chain is hooked. The chain runs through a sheave, whose bearing is cast integral with the frame, but outside the line of the casting. The bolts, by which the frame is secured to three binders are visible in front of the straight edge lugs. The tie bolts to secure the cope are fastened to these binders and the tops are

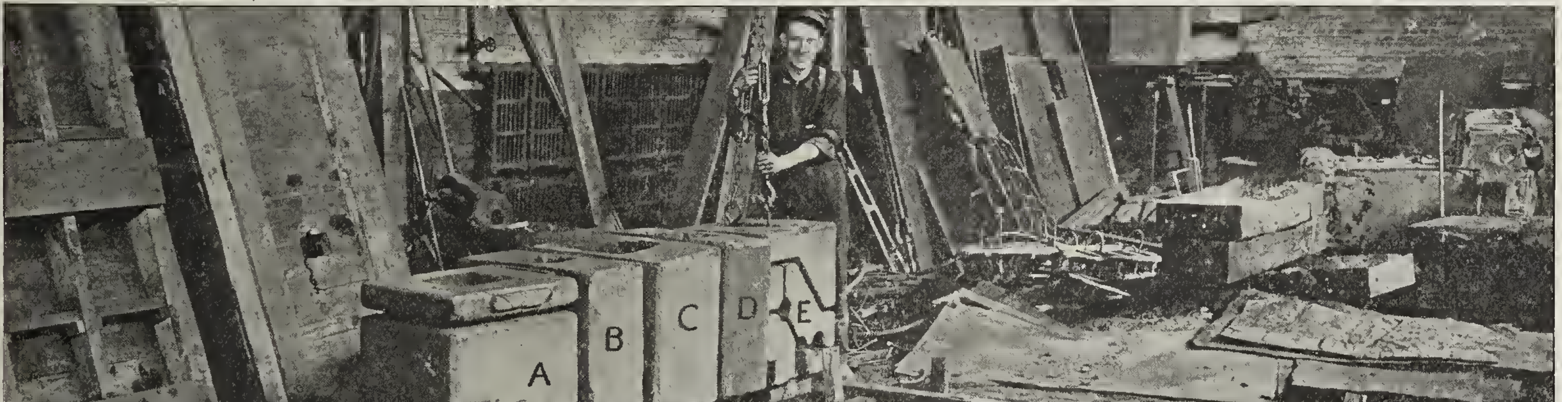
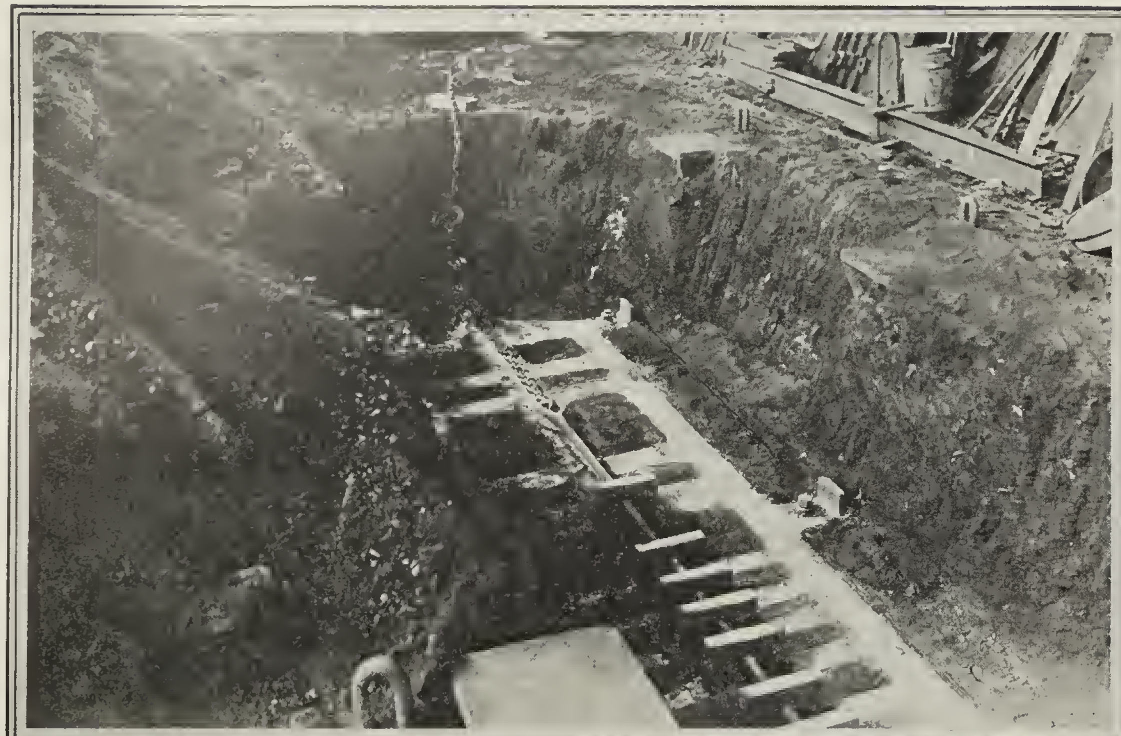
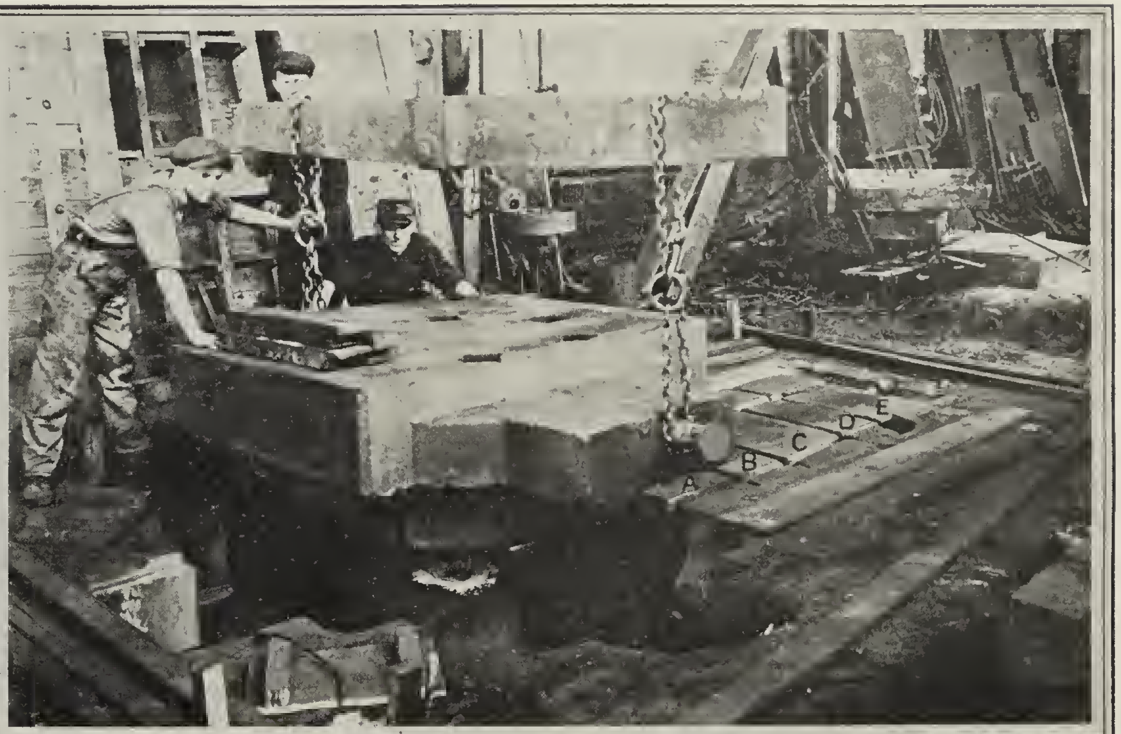
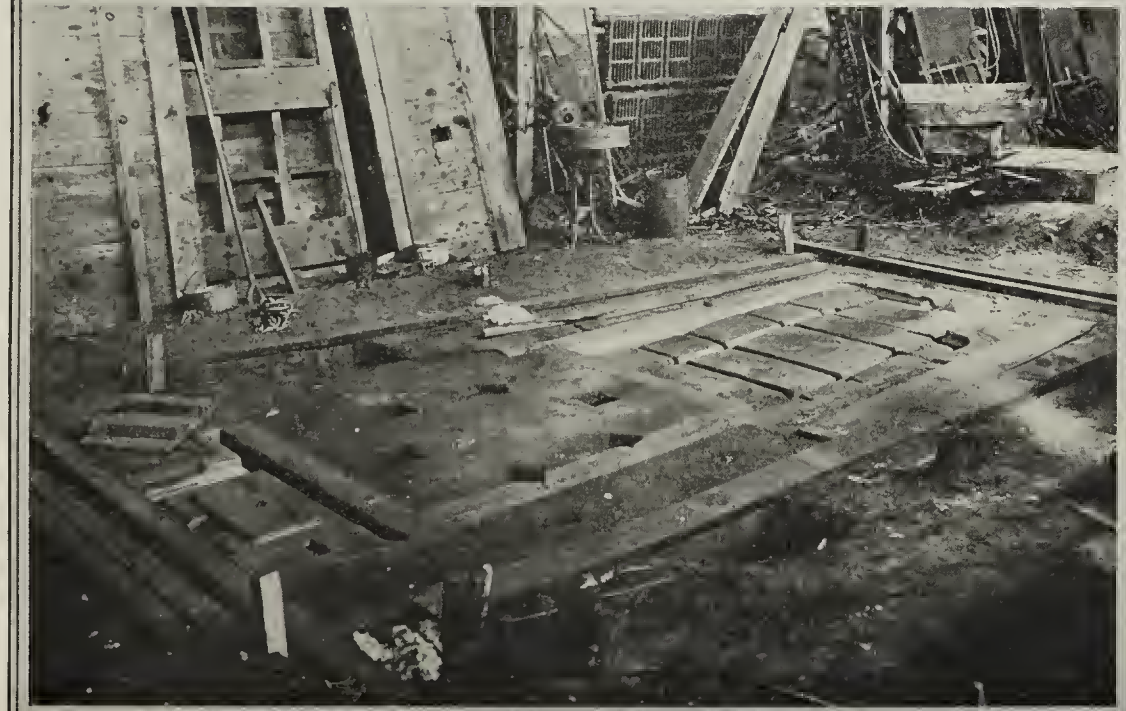


FIG. 1—DRAG OF A 96-INCH GEAR CUTTER BED MOLD READY FOR THE CORES

The author is superintendent of the foundry of the Gurney Elevator Works, Honesdale, Pa.







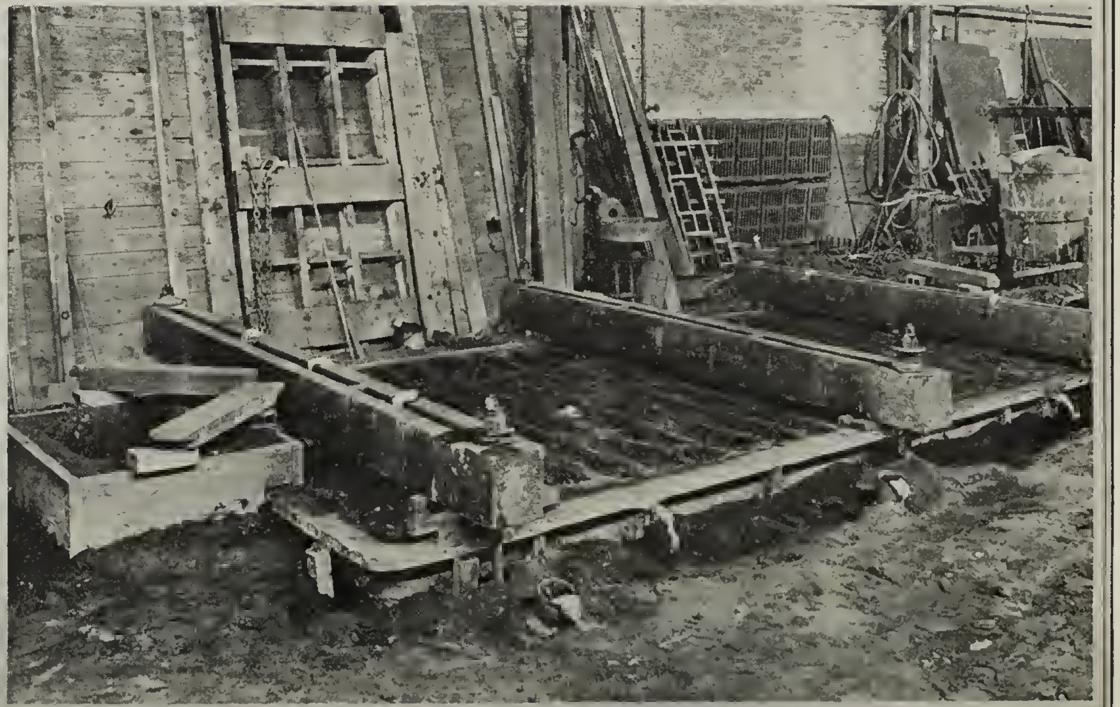


FIG. 2—THE MOLDING PIT SHOWING THE PIT FRAME IN PLACE
FIG. 4—THE DRAG HALF OF THE MOLD CORED-UP

FIG. 3—LOWERING THE MAIN BODY CORE INTO THE MOLD
FIG. 5—THE MOLD READY TO POUR

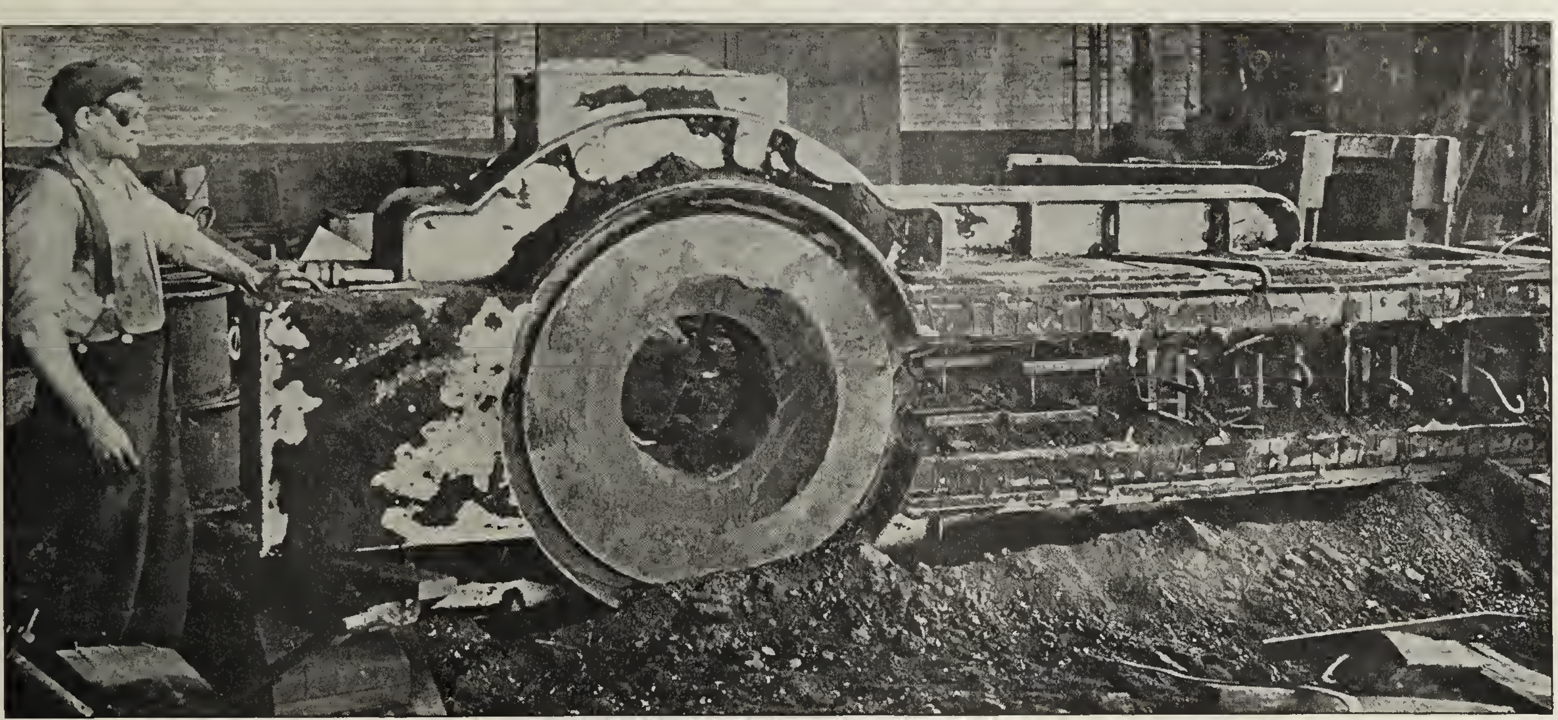


FIG. 6—THE BED CASTING REMOVED FROM THE PIT AND ROLLED OVER ON ITS SIDE

shown in Fig. 2, directly behind the stands which support the cope.

To carry off the gases satisfactorily, a cinder bed was built through the center of the pit, directly underneath the lugs on the frame, which was connected to the vent pipes at the side of the pit. Two of these pipes are shown in Fig. 1, being stuffed with burlap to prevent sand from falling into them and sealing the vent. Straight edges were clamped to the side lugs and so adjusted that the floor of the pit, which coincided with the print for the body cores, was flush with the tops of the center lugs. A little flour marked the location of the lugs in Fig. 1, the rod and chain having been rammed-up under the pit floor. After drying, it was a comparatively simple matter to dig out the sand between the lugs, connect to the cinder bed and then to proceed with the coring Long hook bolts, the ends of which are protruding from the cores in Fig. 6, were hooked under the rod extending through the lugs. The five cores then were lowered over these rods and were secured with a nut on the top end of the rod. The space through which the rod passed was filled with cinders and the holes in the tops of the cores were filled with sand and dried, leaving the mold as shown in Figs. 3 and 4. The main core, to which six smaller pocket cores were bolted, then was lowered into position as illustrated in Figs. 3 and 4.

Fig. 5 is a view of the job ready to pour. The cope was not dried, but was cast green. The bulk of the job was poured from an 8-ton ladle, but it was considered advisable to cut a gate under the joint on the opposite end of the casting to supply about 1500 pounds of hot, fluid metal just before the mold was filled, to make certain that the oil pan would not show cold-shut marks.

After casting, and before taking off the cope, the chain attached to the rod to which the hook bolts were secured, was started with the crane. A slow, steady pull, coupled with a few blows on the chain, caused the rod to slide out of its position underneath the casting and come up to the sheave. When this point was reached, the cores were known to be free. The gates were bared on one end of the casting and two chains were hooked around them. The crane readily lifted one end free, which then was blocked up. Next, a chain was thrown around the center and the whole load was taken to the scratch

(*Continued on page* 387)

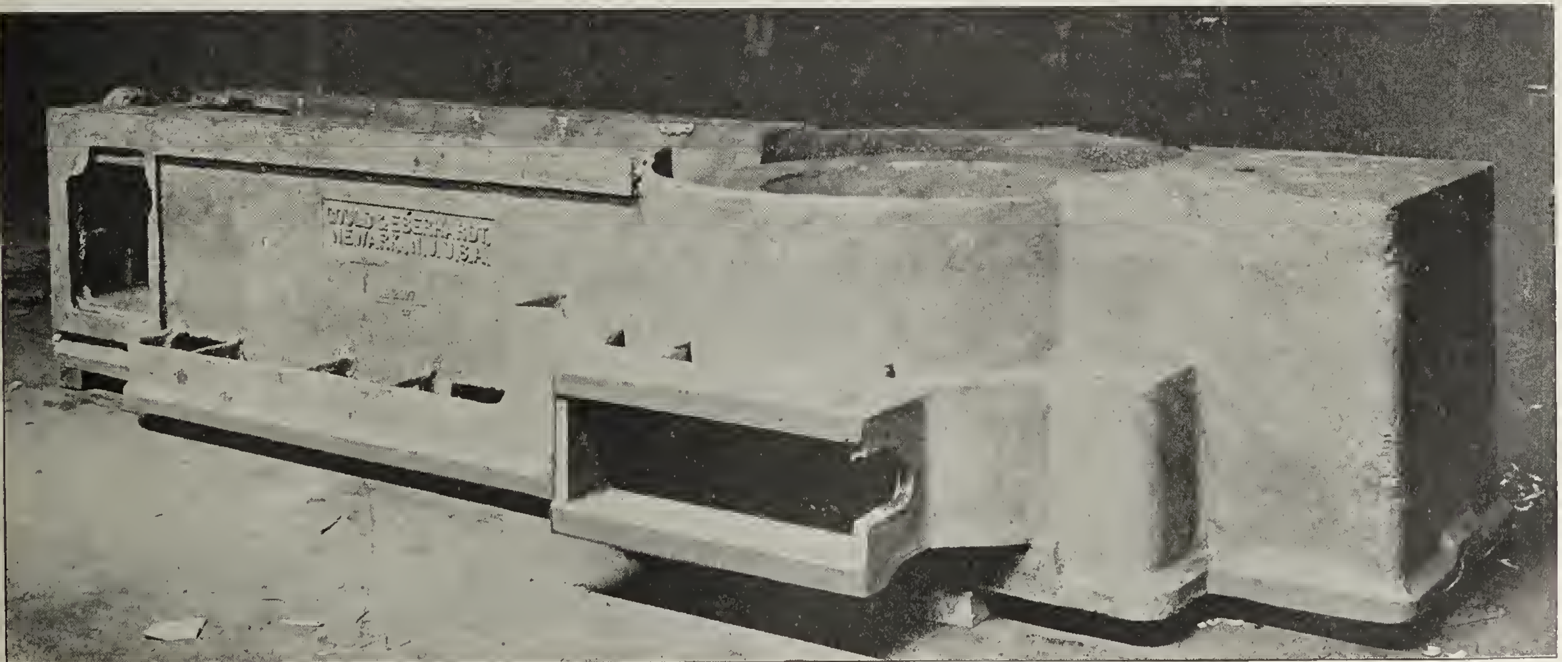


FIG. 7—THE BED CASTING FOR A 96-INCH GEAR CUTTER

Propeller Casting is Essential to Our Defense

Foundrymen Now Will be Required to Make Cast Parts for Ships and a Simple Method of Making Wheels is Here Described

By R H Palmer

AMONG foundrymen generally unusual interest is being manifested in the production of castings for ships. The tremendous shipbuilding program outlined by the government is unparalleled by any similar undertaking. Regardless of whether these vessels are built of wood or steel, they will require thousands of tons of steel, gray iron, brass and bronze castings and the services of many casting manufacturers will have to be enlisted to whom this class of work marks a venture into an unknown field.

Owing to its unusual contour, the welding and casting of the propeller, whether by single blade or integral, seemingly presents the greatest difficulties. Naval architects, also, are inclined to vary the pitch of propellers to meet unusual conditions and the pitches are almost as numerous and varied as the sizes and weights of these castings. The responsibility of matching theory with fact devolves upon the foundryman and he frequently is called upon to meet weird specifications. To foundrymen located on the Atlantic and Pacific coasts, the production of propellers does not present many problems, but the newcomer in this line of work may be compelled to carry on many experiments before he succeeds in making a sound casting. Foundrymen who have specialized in propeller work have designed many novel methods to expedite production and the system to be described is simple and reduces to the minimum the necssary flask equipment. The method of

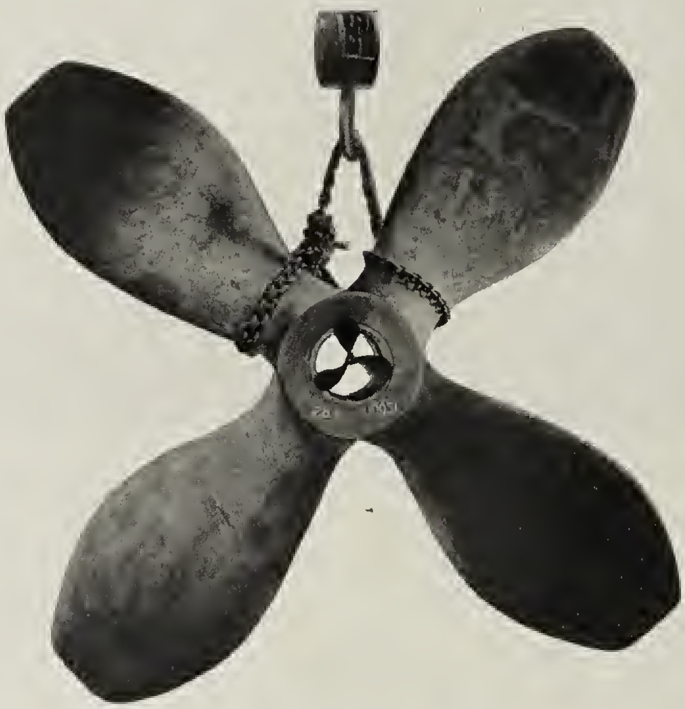


FIG. 1—A 12,000-POUND PROPELLER FOR A PASSENGER LINER WITH A MOTOR BOAT WHEEL IN ITS BORE

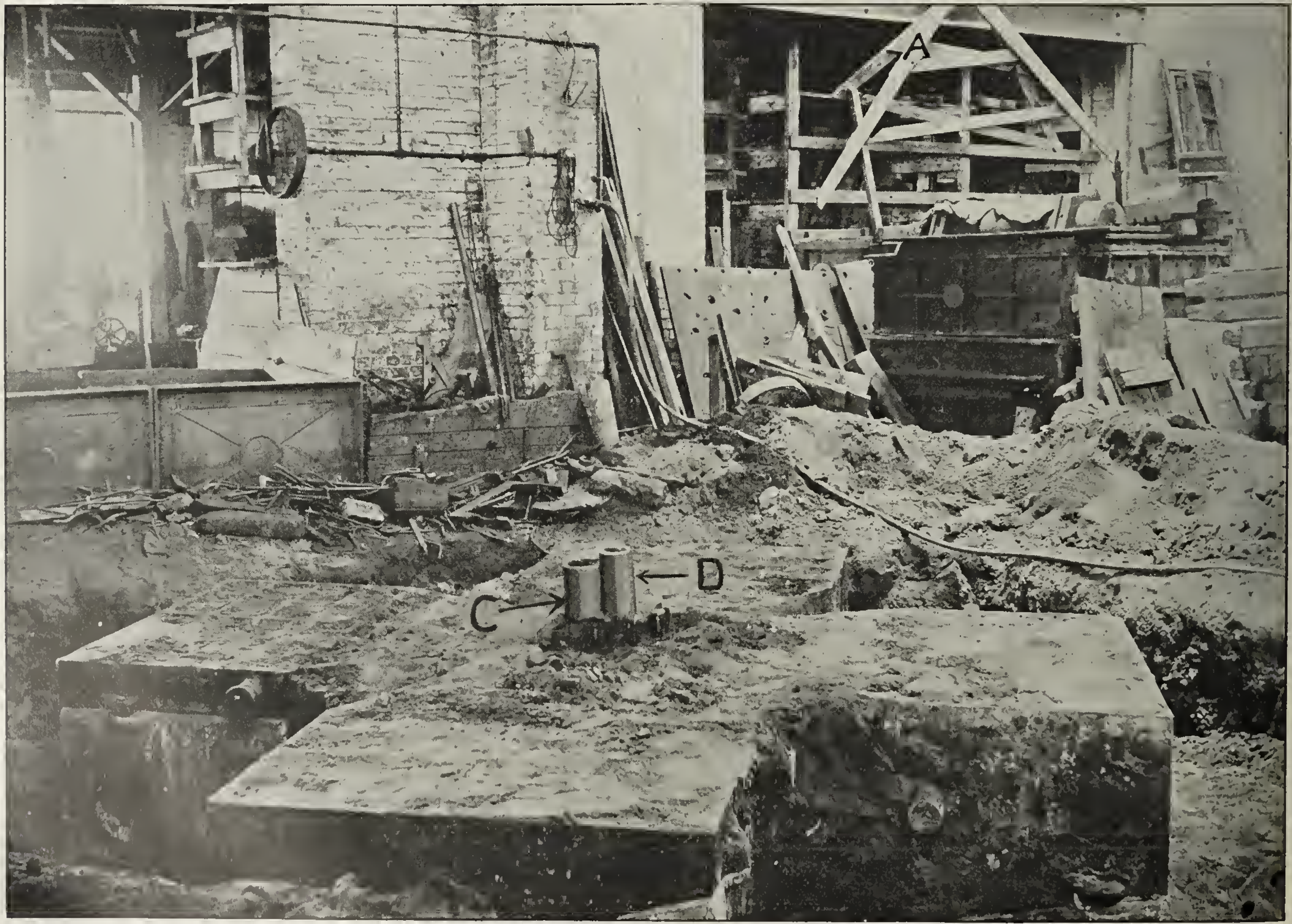


FIG. 2—PROPELLER MOLD AFTER REMOVING WEIGHTS AND CLAMPS AND JUST BEFORE SHAKING OUT. THE RISER IS SHOWN AT *C* AND *D* IS A PIPE PLACED OVER THE VENT IN THE CORE

molding the hub also is novel and effects economies in labor costs.

A propeller mold with the weights removed, just before shaking-out, is shown in Fig. 2 and in Fig. 3 the cope halves of two of the blades have been removed and the gates and riser also are shown. Four flasks are used, one for each blade, which are so ingeniously joined together by the hub to make practically one flask, as illustrated in the top plan of the mold, Fig. 6.

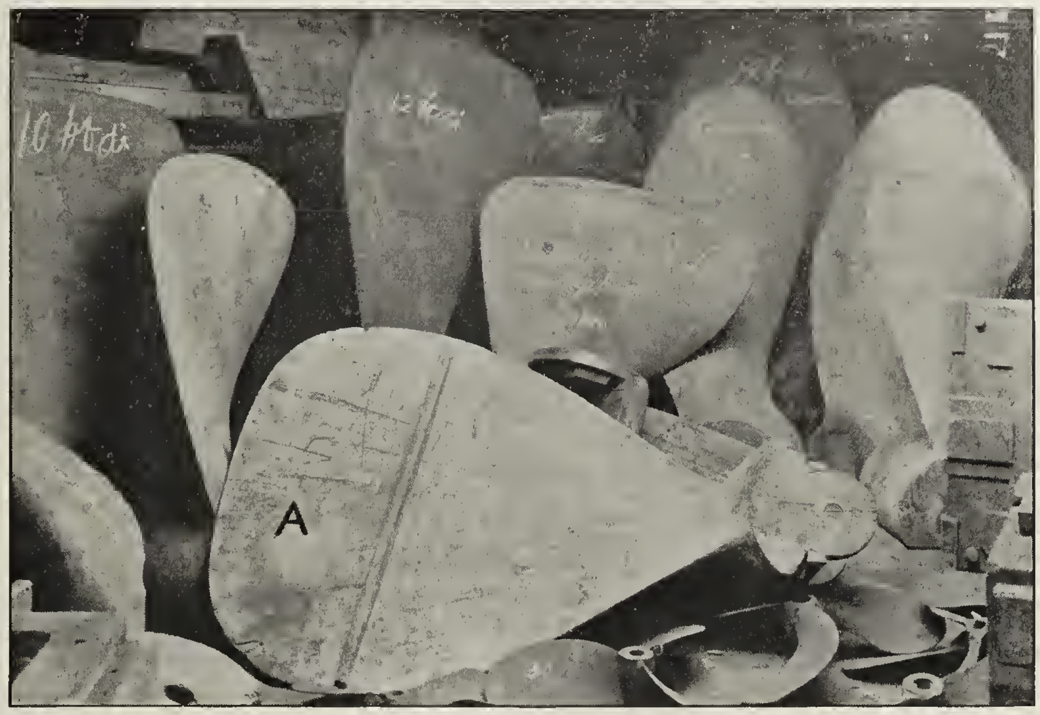


FIG. 4—PATTERNS FOR A WIDE ASSORTMENT OF PROPELLERS THAT CAN BE MOLDED IN ONE SET OF FLASKS

When making the mold a core is used to form the bottom of the hub, which contains a print for the center core and a hole in its center through which the spindle is passed to its seat underneath the core. The four drag flasks then are centered around the spindle to form a cross, as shown in Figs. 2 and 3. Coke or cinder is rammed into the deep side of each flask to the line *A*, Fig. 8, and sand is rammed on top of this to a point about 4 inches below the line where the blade pattern will rest. The wood core print then is lowered over the spindle into the print in the bottom core and the pattern is lowered onto the spindle. A collar, provided with a set screw, holds the hub in place on the spindle. The blade of the pattern is supported by wood cross-pieces which are clamped to ears on the sides of the flasks. Sand next is rammed underneath the pattern blade and a joint is made conforming to the lines of the pattern. The cope half of the flask then is lowered over the pattern and the ramming of the propeller blade is completed.

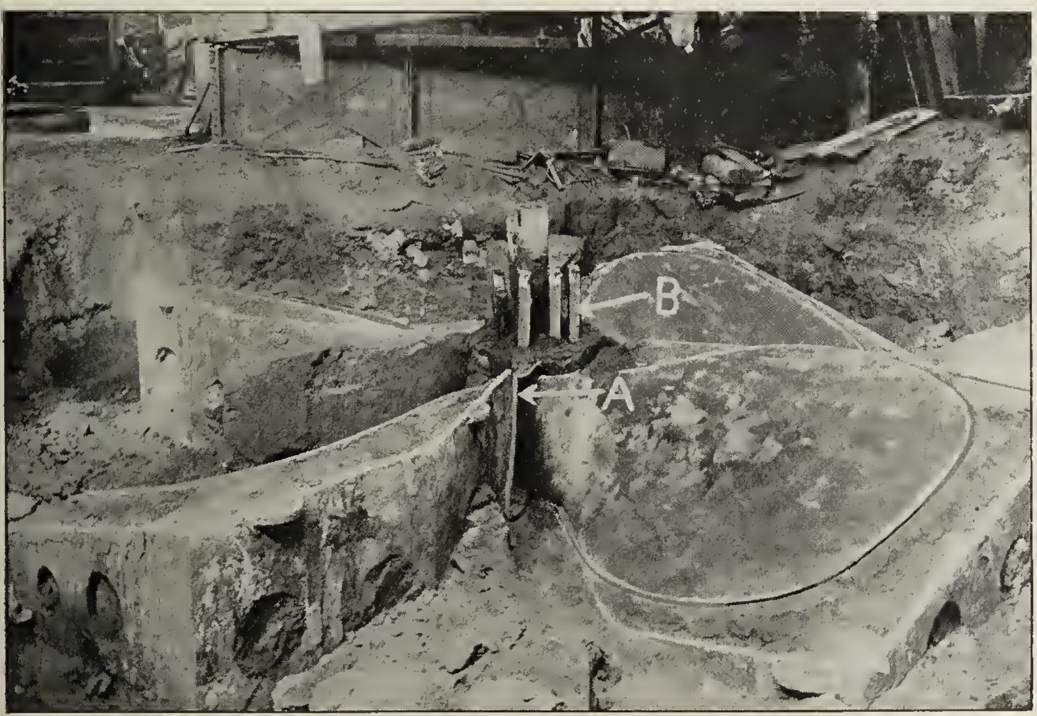


FIG. 3 — PROPELLER PARTLY UNCOVERED SHOWING THE GATES AT *B*

Since this flask equipment is used on a wide range of sizes of propellers having varied pitches and hubs, it is necessary to resort to numerous expedients to adapt the cope flasks to these patterns. In Fig. 4 is shown an assortment of propeller patterns all of which can be molded by this flask equipment. The pattern, *A*, in the foreground, is for a propeller 11 feet 4 inches in diameter, which weighs 7500 pounds. A wheel cast from this pattern is shown on the boring machine, Fig. 5. Other patterns in Fig. 4 are for wheels from 8 to 14 feet in diameter, the latter weighing 14,000 pounds. A propeller for the steamer, NEW HAMPSHIRE, one of the Long Island sound boats of the New England Steamship Co., is illustrated in Fig. 1, and in the bore of this propeller is a small wheel for a launch, also molded and cast in this foundry.

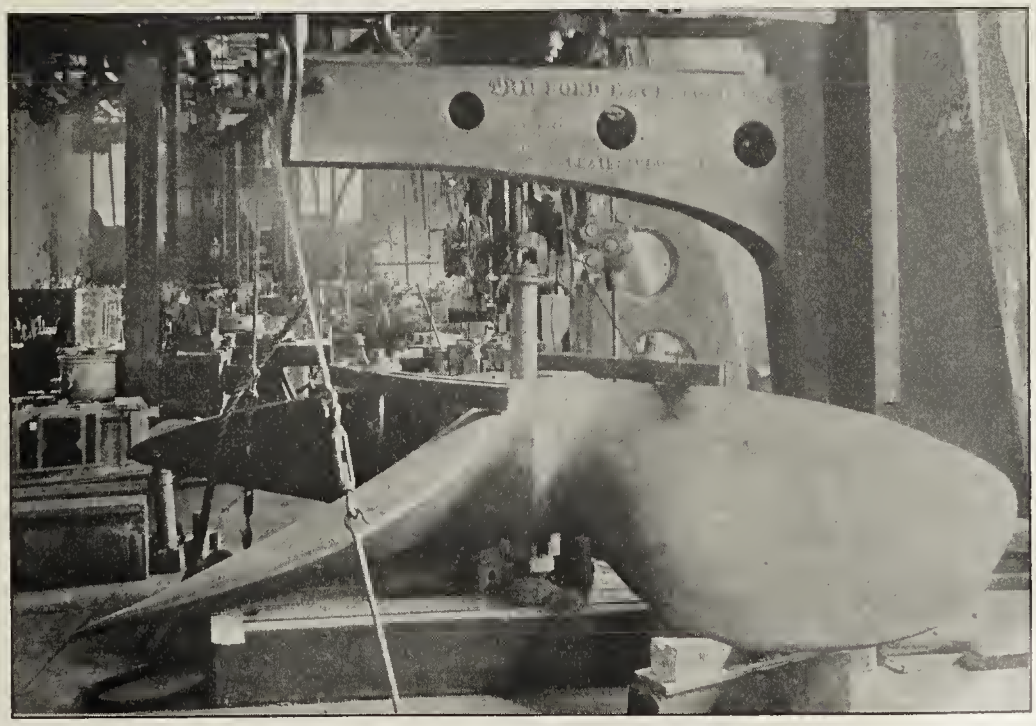


FIG. 5—BORING A LARGE PROPELLER

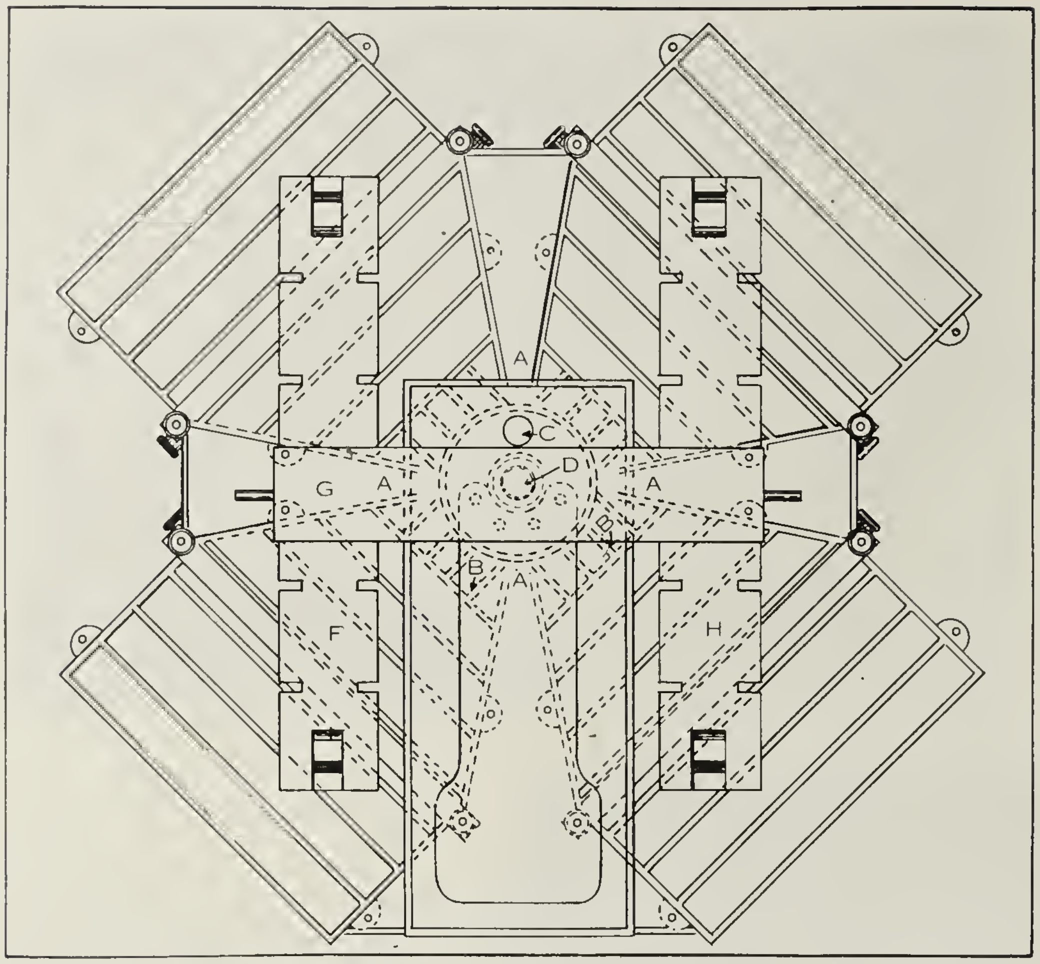


FIG. 6—TOP OF A PROPELLER MOLD SHOWING GATES, RISER AND WEIGHTS

Owing to the differences in the pitch of the blades of the different patterns, the bars of the copes in many cases are as far distant from the pattern as 8 inches, and to support the hanging sand, loose chucks, *B,* Fig. 6, are hung onto the bars, in addition to rods which are bent to shape especially for this purpose. Chucks forming the points of the flasks next to the hubs are bolted in position. After the cope flask has been properly prepared for the pattern, it is rammed and lifted off.

The hubs of some wheels are of such a form that the pattern can be raised on the spindle and swung around to the next drag. However, some hubs are of such a design that it is necessary to lift out the spindle when drawing the pattern.

To assure the accurate centering of the pattern in the flask for the next blade to be molded, a large wood square, in the form of a cross is employed. This device is shown at *A,* Fig. 2. Through a hole in its center it is lowered over the spindle to accurately locate the blade pattern in the adjoining flask. Before the pattern is drawn from the mold just made, the parting of the drag is marked to coincide with a mark on the pattern and these lines, with the aid of the squaring device, make it possible to locate the pattern accurately in the adjoining flask. The foregoing operations are repeated for each of the blades, which are molded independently of each other. The molds then are finished, coated with blacking and dried. The copes are dried in an oven, while the drags are dried in the position in which they are molded.

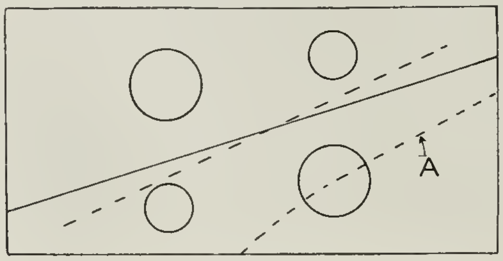


FIG. 8—HEIGHT OF CINDERS AND LOCATION OF PATTERN IN FLASK

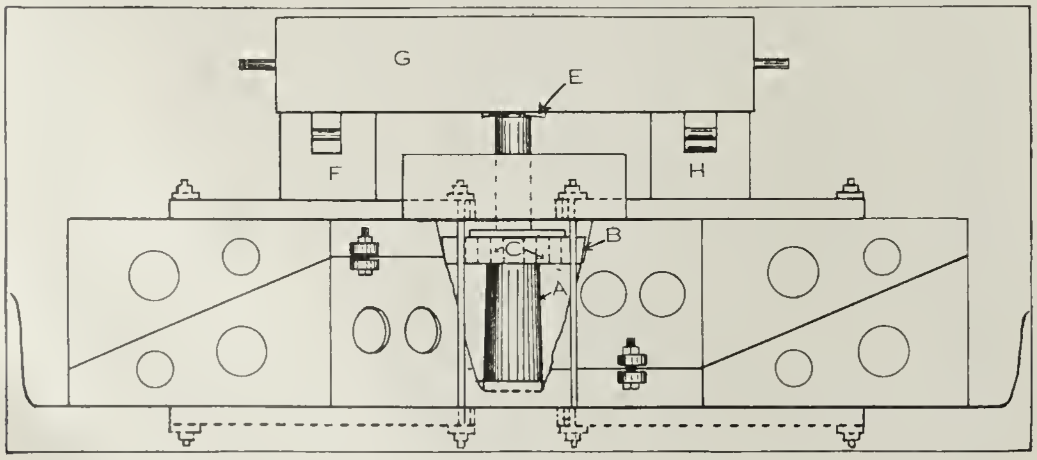


FIG. 7—PART SECTION OF PROPELLER MOLD, SHOWING HUB CORE IN POSITION

After drying, the copes are replaced, but it will be noted that the four-blade molds do not form a perfect hub at the four points, *A,* Fig. 6. After the copes have been bolted to the drags, false pieces are inserted at the points, *A,* Fig. 6, to complete the hub. Sand is rammed against these false pieces to complete the hub section of the mold, after which it is coated with blacking and dried with fire baskets.

The center core, *A,* Fig. 7, then is set in place. The part of this core, shown at *B,* forms the top of the hub of the casting. This hub core is beveled on the edge, and in molding this print in the copes, the sides are sloped to conform to the level on this bead on the center core. After the center core is set, waste is tucked into the openings around the head of the center core and gate sticks are placed in the gate hole in the core. To form a riser, a piece of pipe is placed at *D,* Fig. 6. Sand then is rammed over the core. The mold then is bolted and weighted down, as shown at *F, G* and *H,* Fig. 7. The gate sticks then are withdrawn, the runner is built and the mold is ready for pouring. To hold down the center core, wedges *E,* Fig. 7, are driven between the weight *G* and the section of pipe to hold down the center core *A.*

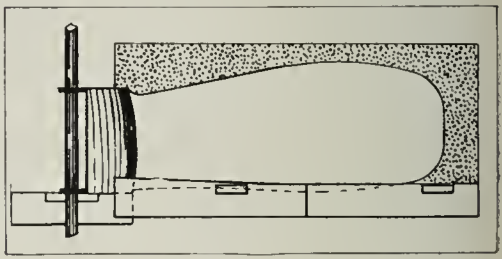


FIG. 9—HOW THE PATTERN IS SUPPORTED ON A SPINDLE WHILE IT IS BEING MOLDED IN THE DRAG

The New York office of White & Bro., Philadelphia smelters and refiners, has been removed to 821 Trinity building. G. C. Dickinson is in charge.

Being compelled to seek larger quarters, the New York office of the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., has been removed from 50 to 30 Church street. For the same reason, the Philadelphia office of this company has been removed from the Stephen Girard to the Bulletin building.

Selenium in Copper

Selenium, when added to copper, produces unusual results. The addition of 0.5 per cent produces castings that contain minute pits which are regularly distributed and are similar to pin holes. After pouring, the copper swells in the risers and sprues, curving up at the edges, leaving the top slightly convex. The surfaces of both sprues and risers were smooth when solid, and while the liquid metal was coming up in the risers, only a very slight spitting was noted. Before being poured, the copper was very fluid.

The most remarkable feature of the copper was that its properties were entirely changed by the addition of this small amount of selenium. Instead of being tough and difficult to work with machine tools, the copper could be cut easily. A bar, 1½ inches square, was cut by a hack saw with little effort. The copper was not brittle and could be bent double without cracking. The effect of selenium on copper and its alloys appears to be much worse than that of sulphur. This element is used extensively in alloys containing high percentages of lead, as it prevents segregation of this metal. Neither selenium nor tellurium can be used for this purpose, although they bear a close resemblance to sulphur. It naturally would be assumed that since the boiling point of selenium is higher than that of sulphur it would have a better effect than sulphur as a lead retaining agency.

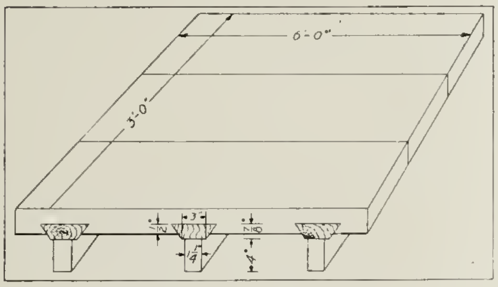
Seaman-Sleeth Co. is Sold and J. S. Seaman Retires

The properties of the Seaman-Sleeth Co. and the Phoenix Roll Works, Pittsburgh, have been purchased by William Morris Imbrie & Co., New York bankers, for $2,000,000 and have been formally transferred to the Pittsburgh Rolls Corp. After negotiations for the purchase were concluded, a meeting of stockholders and directors was held in the offices of Clarence Burleigh, a corporation lawyer, Frick building Pittsburgh.

The new concern has been capitalized at $3,000,000, of which $1,000,000 will be 6 per cent first mortgage gold bonds, $1,500,000 common stock and $500,000 7 per cent cumulative preferred stock. In addition, $1,000,000 of common stock is reserved for the conversion of bonds.

Officers of the Pittsburgh Rolls Corp. follow: Chairman of the board, Joseph S. Seaman, who had been president of the Seaman-Sleeth Co.; president, David L. Eynon, who had been general manager of the Seaman-Sleeth interests; vice president and treasurer, H. R. Warfield, for 10 years connected with William Morris Imbrie & Co.; secretary, H. H. Meckley, who had acted as secretary of the Seaman-Sleeth Co. Mr. Warfield represented the purchasers in the transaction. He has been actively associated in organization work for a number of years and is vice president of the Savannah & Atlanta railroad and one of the receivers of the Georgia & Florida ralroad.

The Seaman-Sleeth Co. was organized about 60 years ago by J. S. Seaman and associates. For almost 50 years, the company has specialized in the manufacture of chilled and sand rolls and pinions; it enjoys an extensive trade in this country and has exported many rolls to Canada, Mexico, Australia and Japan. The net profits of the company for 1912-1916 were $742,992.57. In 1916, the net earnings of the company were $296,144.58 and the net profits for the first four months of 1917 were $104,993.59. The company has been extending its manufacturing facilities ever since its origin. An open-hearth steel furnace now is being installed.



CONSTRUCTION BOARD OF THREE PLANKS HELD TOGETHER BY DOVETAILED CROSS RAILS

In co-operation with the bureau of mines, an investigation of the electric melting of brass is being conducted at Cornell university, the electric furnace equipment being installed in Morse hall. The experiments indicate that the use of a suitable electric furnace will materially reduce melting losses and the bureau of mines now is testing an electric furnace built according to the design worked out by the laboratory tests. This furnace is of commercial size and is being tested with a view to ascertaining its suitability for such processes as are used for cartridge and shrapnel cases.

A 10 per cent aluminum bronze to which was added 1 per cent of 30 per cent manganese-copper had the following physical properties: Ultimate strength, 63,800 pounds per square inch; elastic limit, 19,700 pounds per square inch and elongation in two inches, 49.3 per cent.

A Patternmaker's Construction Board

By M. E. Duggan

Every patternmaker appreciates the advantages of a well-made table or construction board, on which he can lay out and build-up his pattern in a practical manner and with a feeling of confidence in the accuracy of his measurements.

In one large shop, the construction board is considered just as necessary as a bench or any of the other tools in the pattern shop. Each patternmaker is furnished with one of these boards of standard design and dimensions. The wooden horses also conform to a standard drawing.

The boards are constructed of 2 x 12-inch well-seasoned pine planks, fastened together by dovetail cross rails, as shown in the accompanying illustration. Maple is used for the dovetails, although it is common practice to joint and fasten the boards of a table together with glue. In this particular shop no glue is used in the construction of the table. Construction boards frequently require top dressing. The glued boards must be dressed by a hand plane, a slow and unsatisfactory method. When glue is not used, the dovetail cross rails can be removed, and a light cut taken over the top surface by passing each board through a power planer. The three boards are then assembled and the table is ready for use, the work requiring little labor or loss of time.

Every pattern returned from the foundry is covered, more or less, with sand and grit, and when one of these patterns is placed on the construction board, much of this sand and grit is ground into the board. Sand and grit in a board that is to be planed spells destruction to edge tools. Therefore, if convenient, the boards should not be dressed at a time when the planer knives are in good cutting condition. In many instances the job can be reserved until the planer knives require re-sharpening.

How to Melt Babbitt Metal

When melting babbitt metal in a kettle the surface of the metal always should be kept covered with powdered charcoal and the temperature of the bath should be maintained at approximately 500 degrees Cent. Before being ingoted, this temperature should be lowered somewhat for both lead and tin base alloys and 450 to 470 degrees Cent. will be found to be a good pouring temperature. When the babbitt is being run directly into bearings, the shell should be heated to about 100 degrees to prevent blowholes. A Brinell hardness of 23.5 for lead base and 30 for tin base alloys is considered best.

How the Foundry Was Dressed W

Personal Reminiscences of the Founder of This P
Experts in Their Respective Branches of Casting

TWENTY-FIVE years ago this month the first copy of THE FOUNDRY was published and it has appeared regularly each month ever since.

So this is *some* anniversary.

The editors of THE FOUNDRY have asked me to write a few lines for this issue,

Reviewing in some slight measure the history of this journal.

At the beginning, the entire editorial and business staff of THE FOUNDRY for the first year or so of its existence,

Including the editor, advertising manager, advertising representative, circulation manager, bookkeeper, stenographer, mailing clerk, office boy and janitor,

Consisted of one man,

And I was that man.

Therefore, we had no personal quarrels or serious differences of opinion among our employes,

And no one struck for higher wages.

We got along splendidly.

Only when the editor went out of town, or when the office boy left the office—

That little unostentatious room near the roof of a 4-story building, where they did their work—was locked up.

And incidentally, if the editor or advertising man went away on a trip, he did not ride in a Pullman.

That would have cost at least two dollars,

And for that reason, he rode in another section of the train.'

But THE FOUNDRY prospered.

It had some hard sledding at first, of course,

Having been started with only an insignificant amount of capital,

So small that in these days it would seem like a huge joke.

But THE FOUNDRY grew without a halt

From 32 pages, 9½ x 6½ inches to its present size of 12 x 9 inches and over 300 pages.

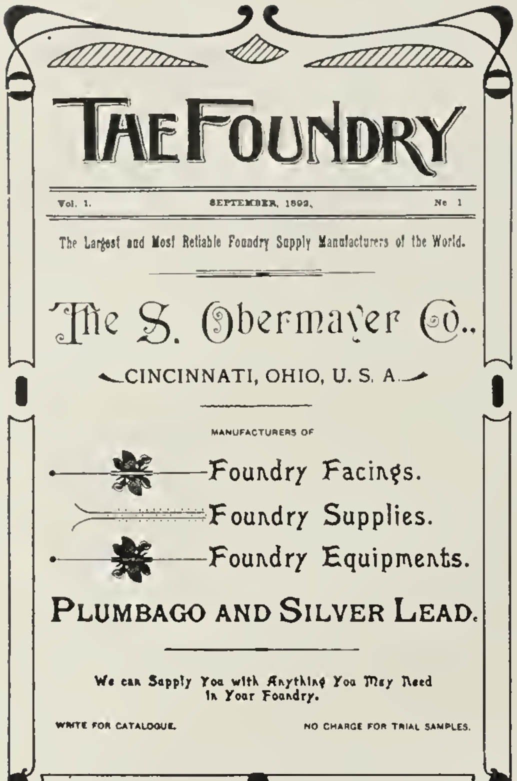
Prior to its inaugural a small circular was prepared and sent out to a list of several hundred names.

Some of these circulars were sent to men, more or less well known as owners, operators, superintendents, foremen, etc.,

Asking their judgment as to the feasibility and possible success of a publication of this character.

It was thought the circular would at least arouse some interest and would be a shrewd piece of advertising.

And with only one exception—that one a personal friend—all wrote that no possible success could come of the venture,



THE FOUNDRY

Vol. 1. SEPTEMBER, 1892, No 1

The Largest and Most Reliable Foundry Supply Manufacturers of the World.

The S. Obermayer Co.,

CINCINNATI, OHIO, U. S. A.

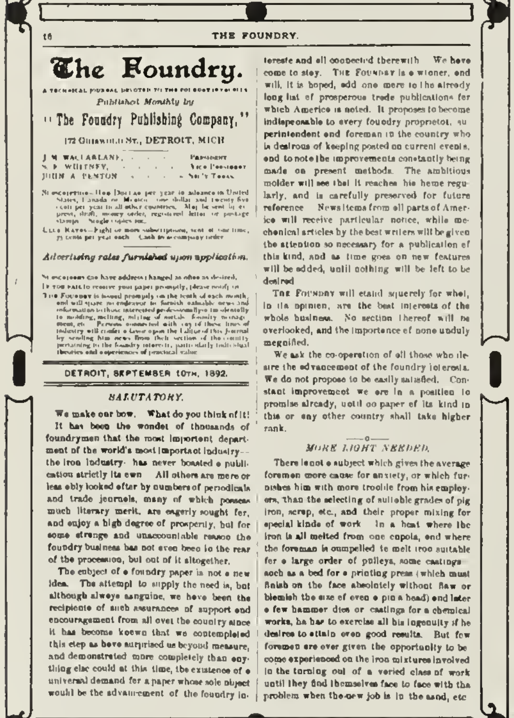
MANUFACTURERS OF

Foundry Facings.
Foundry Supplies.
Foundry Equipments.

PLUMBAGO AND SILVER LEAD.

We can Supply You with Anything You May Need In Your Foundry.

WRITE FOR CATALOGUE. NO CHARGE FOR TRIAL SAMPLES.



16 THE FOUNDRY.

The Foundry.

A TECHNICAL JOURNAL DEVOTED TO THE FOUNDRY INTERESTS

Published Monthly by

"The Foundry Publishing Company,"

172 GRISWOLD ST., DETROIT, MICH

J. M. MACFARLANE, President
S. P. WHITNEY, Vice President
JOHN A. PENTON, Sec'y Treas.

Advertising rates furnished upon application.

DETROIT, SEPTEMBER 10TH, 1892.

SALUTATORY.

We make our bow. What do you think of it!

It has been the wonder of thousands of foundrymen that the most important department of the world's most important industry—the iron industry—has never boasted a publication strictly its own. All others are more or less ably looked after by numbers of periodicals and trade journals, many of which possess much literary merit, are eagerly sought for, and enjoy a high degree of prosperity, but for some strange and unaccountable reason the foundry business has not even been in the rear of the procession, but out of it altogether.

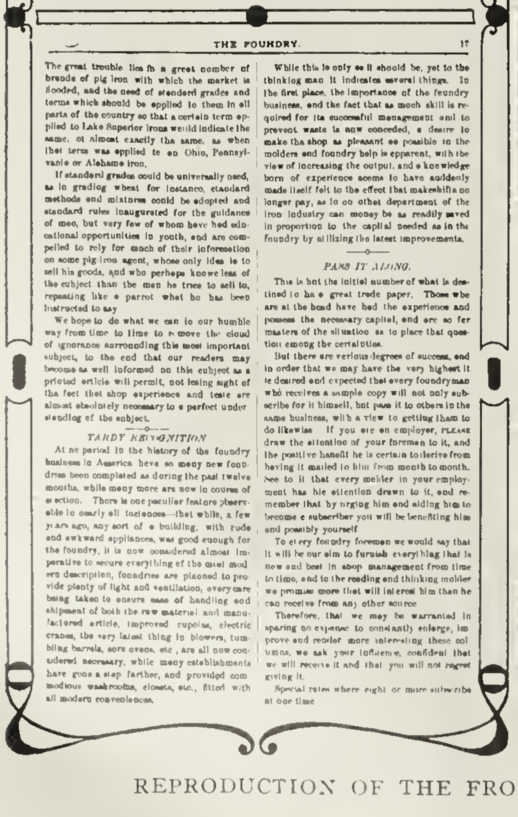
The subject of a foundry paper is not a new idea. The attempt to supply the need is, but although always sanguine, we have been the recipients of such assurances of support and encouragement from all over the country since it has become known that we contemplated this step as have surprised us beyond measure, and demonstrated more completely than anything else could at this time, the existence of a universal demand for a paper whose sole object would be the advancement of the foundry interests and all connected therewith. We have come to stay. THE FOUNDRY is a winner, and will, it is hoped, add one more to the already long list of prosperous trade publications for which America is noted. It proposes to become indispensable to every foundry proprietor, superintendent and foreman in the country who is desirous of keeping posted on current events, and to note the improvements constantly being made on present methods. The ambitious molder will see that it reaches his home regularly, and is carefully preserved for future reference. News items from all parts of America will receive particular notice, while mechanical articles by the best writers will be given the attention so necessary for a publication of this kind, and as time goes on new features will be added, until nothing will be left to be desired.

THE FOUNDRY will stand squarely for what, in its opinion, are the best interests of the whole business. No section thereof will be overlooked, and the importance of none unduly magnified.

We ask the co-operation of all those who desire the advancement of the foundry interests. We do not propose to be easily satisfied. Constant improvement we are in a position to promise already, until no paper of its kind in this or any other country shall take higher rank.

MORE LIGHT NEEDED.

There is not a subject which gives the average foreman more cause for anxiety, or which furnishes him with more trouble from his employers, than the selecting of suitable grades of pig iron, scrap, etc., and their proper mixing for special kinds of work. In a heat where the iron is all melted from one cupola, and where the foreman is compelled to melt iron suitable for a large order of pulleys, some castings such as a bed for a printing press (which must finish on the face absolutely without flaw or blemish the size of even a pin's head) and later a few hammer dies or castings for a chemical works, he has to exercise all his ingenuity if he desires to attain even good results. But few foremen are ever given the opportunity to become experienced on the iron mixtures involved in the turning out of a varied class of work until they find themselves face to face with the problem when the new job is in the sand, etc



THE FOUNDRY. 17

The great trouble lies in a great number of brands of pig iron with which the market is flooded, and the need of standard grades and terms which should be applied to them in all parts of the country so that a certain term applied to Lake Superior irons would indicate the same, or almost exactly the same, as when that term was applied to an Ohio, Pennsylvania or Alabama iron.

If standard grades could be universally used, as in grading wheat for instance, standard methods and mixtures could be adopted and standard rules inaugurated for the guidance of men, but very few of whom have had educational opportunities in youth, and are compelled to rely for much of their information on some pig iron agent, whose only idea is to sell his goods, and who perhaps knows less of the subject than the men he tries to sell to, repeating like a parrot what he has been instructed to say.

We hope to do what we can in our humble way from time to time to remove the cloud of ignorance surrounding this most important subject, to the end that our readers may become as well informed on this subject as a printed article will permit, not losing sight of the fact that shop experience and taste are almost absolutely necessary to a perfect understanding of the subject.

TARDY RECOGNITION.

At no period in the history of the foundry business in America have so many new foundries been completed as during the past twelve months, while many more are now in course of erection. There is one peculiar feature observable in nearly all instances—that while, a few years ago, any sort of a building, with rude and awkward appliances, was good enough for the foundry, it is now considered almost imperative to secure everything of the most modern description, foundries are planned to provide plenty of light and ventilation, every care being taken to ensure ease of handling and shipment of both the raw material and manufactured article, improved cupolas, electric cranes, the very latest thing in blowers, tumbling barrels, core ovens, etc., are all now considered necessary, while many establishments have gone a step farther, and provided commodious washrooms, closets, etc., fitted with all modern conveniences.

While this is only as it should be, yet to the thinking man it indicates several things. In the first place, the importance of the foundry business, and the fact that as much skill is required for its successful management and to prevent waste is now conceded, a desire to make the shop as pleasant as possible to the molders and foundry help is apparent, with the view of increasing the output, and a knowledge born of experience seems to have suddenly made itself felt to the effect that makeshifts no longer pay, as in no other department of the iron industry can money be as readily saved in proportion to the capital needed as in the foundry by utilizing the latest improvements.

PASS IT ALONG.

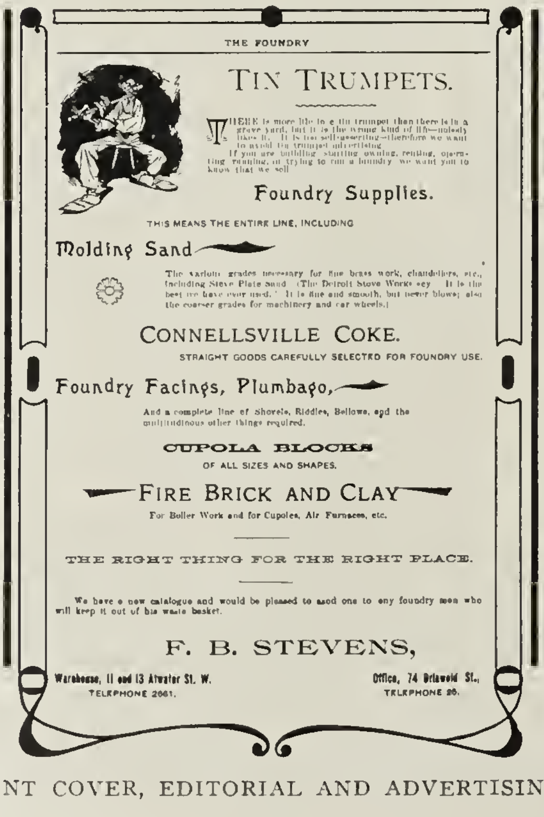
This is but the initial number of what is destined to be a great trade paper. Those who are at the head have had the experience and possess the necessary capital, and are so far masters of the situation as to place that question among the certainties.

But there are various degrees of success, and in order that we may have the very highest it is desired and expected that every foundryman who receives a sample copy will not only subscribe for it himself, but pass it to others in the same business, with a view to getting them to do likewise. If you are an employer, PLEASE draw the attention of your foremen to it, and the positive benefit he is certain to derive from having it mailed to him from month to month. See to it that every melter in your employment has his attention drawn to it, and remember that by urging him and aiding him to become a subscriber you will be benefiting him and possibly yourself.

To every foundry foreman we would say that it will be our aim to furnish everything that is new and best in shop management from time to time, and to the reading and thinking molder we promise more that will interest him than he can receive from any other source.

Therefore, that we may be warranted in sparing no expense to constantly enlarge, improve and render more interesting these columns, we ask your influence, confident that we will receive it and that you will not regret giving it.

Special rates where eight or more subscribe at one time.



THE FOUNDRY

TIN TRUMPETS.

THERE is more life in a tin trumpet than there is in a grave yard, but it is the wrong kind of life—nobody likes it. It is too self-asserting—therefore we want to avoid tin trumpet advertising.

If you are building, starting, owning, renting, operating, running, or trying to run a foundry, we want you to know that we sell

Foundry Supplies.

THIS MEANS THE ENTIRE LINE, INCLUDING

Molding Sand

The various grades necessary for fine brass work, chandeliers, etc., including Stove Plate Sand (The Detroit Stove Works say "It is the best we have ever used." It is fine and smooth, but never blows; also the coarser grades for machinery and car wheels.)

CONNELLSVILLE COKE.

STRAIGHT GOODS CAREFULLY SELECTED FOR FOUNDRY USE.

Foundry Facings, Plumbago,

And a complete line of Shovels, Riddles, Bellows, and the multitudinous other things required.

CUPOLA BLOCKS

OF ALL SIZES AND SHAPES.

FIRE BRICK AND CLAY

For Boiler Work and for Cupolas, Air Furnaces, etc.

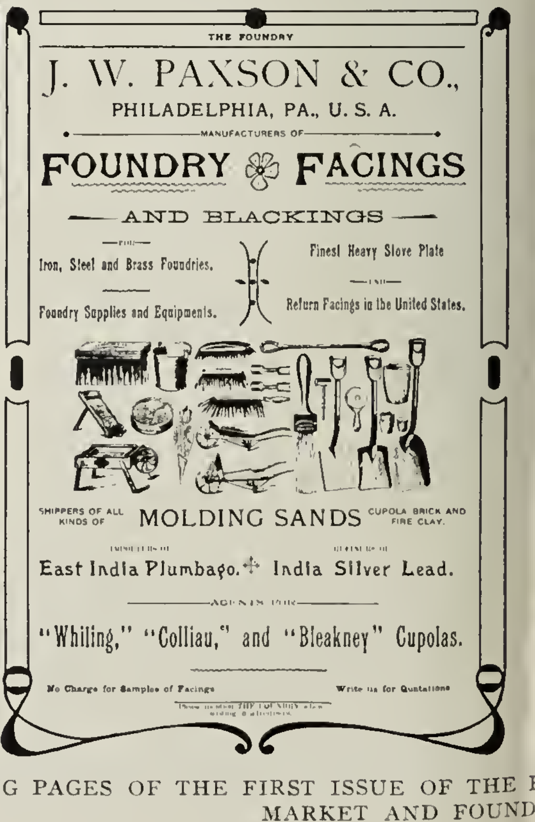
THE RIGHT THING FOR THE RIGHT PLACE.

We have a new catalogue and would be pleased to send one to any foundry men who will keep it out of his waste basket.

F. B. STEVENS,

Warehouse, 11 and 13 Atwater St. W.
TELEPHONE 2061.

Office, 74 Griswold St.,
TELEPHONE 26.



THE FOUNDRY

J. W. PAXSON & CO.,

PHILADELPHIA, PA., U. S. A.

MANUFACTURERS OF

FOUNDRY FACINGS

AND BLACKINGS

FOR

Iron, Steel and Brass Foundries.

Foundry Supplies and Equipments.

Finest Heavy Stove Plate

AND

Return Facings in the United States.

SHIPPERS OF ALL KINDS OF MOLDING SANDS CUPOLA BRICK AND FIRE CLAY.

IMPORTERS OF East India Plumbago. REFINERS OF India Silver Lead.

AGENTS FOR

"Whiting," "Colliau," and "Bleakney" Cupolas.

No Charge for Samples of Facings. Write us for Quotations

REPRODUCTION OF THE FRONT COVER, EDITORIAL AND ADVERTISING PAGES OF THE FIRST ISSUE OF THE FOU
MARKET AND FOUNDRY

Made Its Bow 25 Years Ago

With a Few Sidelights on Its Early Struggles and Discuss the Progress Made in a Quarter Century

By John A Penton

Giving various reasons.

One said, "not a sufficiently important industry to support a paper."

Another, "not enough readers."

Still another, "no future to advertising in a foundry paper."

"No one interested in foundry matters will read it."

"No one reads anything about foundry subjects."

"Foundrymen do not read anyhow."

But in spite of all this adverse judgment, I decided to go ahead.

I found then, and have found often since,

That the superficial opinion of the uninformed or impractical was, is and always is liable to be in error.

In the beginning there were only one or two men who had written anything on foundry subjects.

These were Thos. D. West, Simpson Bolland and Robert E. Masters.

All of these I knew very well and intimately.

The first two have passed out of this life,

And Mr. Masters is, I think, living in the south.

They did not, however, write for THE FOUNDRY.

It was not of sufficient importance.

And their contributions, almost exclusively, were sent to *The American Machinist*,

Which in those days was the only publication that considered foundry practice.

But gradually THE FOUNDRY increased in size, reputation, character and influence

And attracted to itself the best literary ability of the country.

For many years it has covered every branch of the foundry industry, not only practically, but energetically, and with much initiative.

From the beginning, of course, we had many strange experiences,

Largely connected with our effort to keep going on little or no capital, credit or anything else,

But a first class, unlimited supply of high grade, thirty-third degree nerve and self-confidence.

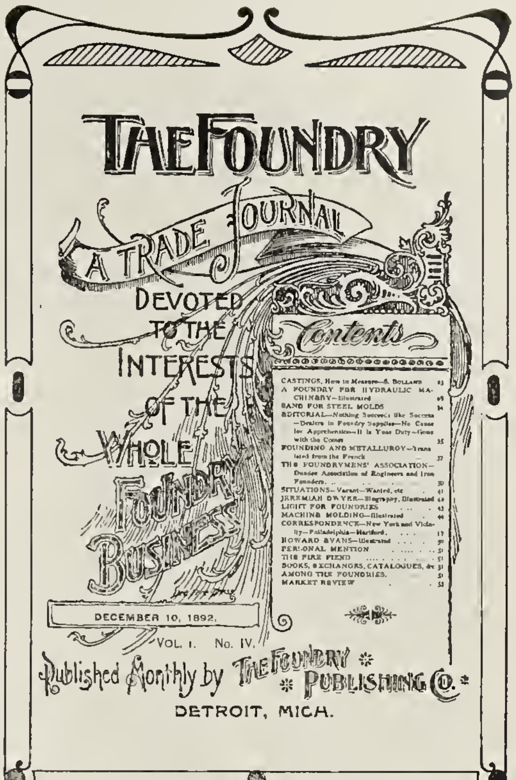
Incidentally, we might mention, that that was the main backing of THE FOUNDRY from the beginning and was its chief asset for many years.

A recital of some of our experiences might make interesting reading, but they largely concern the writer and, hence, with some degree of modesty, can be omitted.

But the outstanding factor contributing to the success of THE FOUNDRY

Has been the peculiar personal loyalty of its readers and advertisers,

From the very beginning and in all parts of the world.



THE FOUNDRY

A TRADE JOURNAL DEVOTED TO THE INTERESTS OF THE WHOLE FOUNDRY BUSINESS

Contents

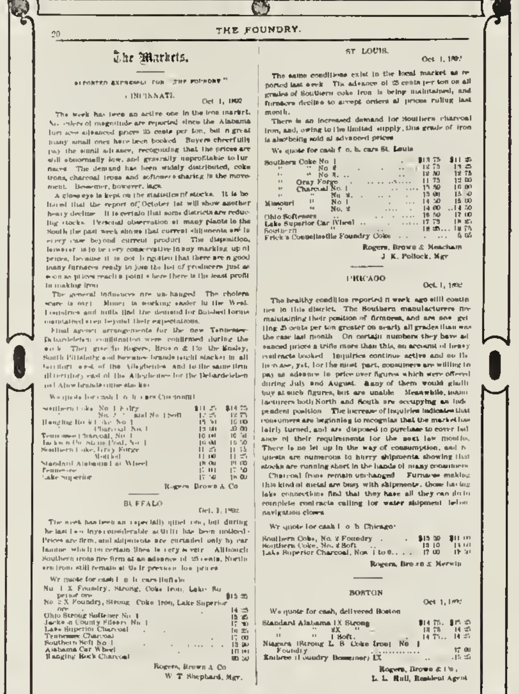
- CASTINGS, How to Measure—S. Bolland 33
- A FOUNDRY FOR HYDRAULIC MACHINERY—Illustrated 33
- SAND FOR STEEL MOLDS 34
- EDITORIAL—Nothing Succeeds like Success—Dealers in Foundry Supplies—No Cause for Apprehension—It is Your Duty—Gone with the Comet 35
- FOUNDING AND METALLURGY—Translated from the French 37
- THE FOUNDRYMENS' ASSOCIATION—Dundee Association of Engineers and Iron Founders 39
- SITUATIONS—Vacant—Wanted, etc 41
- JEREMIAH DWYER—Biography, Illustrated 42
- LIGHT FOR FOUNDRIES 43
- MACHINE MOLDING—Illustrated 44
- CORRESPONDENCE—New York and Vicinity—Philadelphia—Hartford 47
- HOWARD EVANS—Illustrated 50
- PERSONAL MENTION 51
- THE FIRE FIEND 51
- BOOKS, EXCHANGES, CATALOGUES, &c 51
- AMONG THE FOUNDRIES 51
- MARKET REVIEW 53

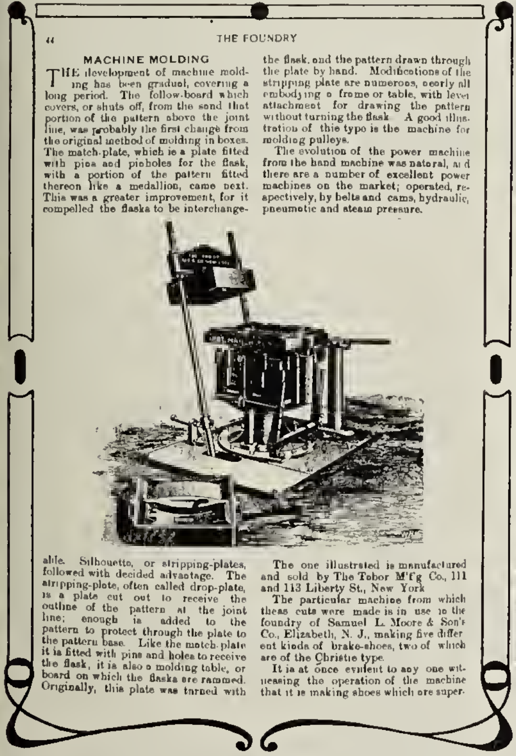
DECEMBER 10, 1892.

VOL. I. No. IV.

Published Monthly by The Foundry Publishing Co.

DETROIT, MICH.





" THE FOUNDRY

MACHINE MOLDING

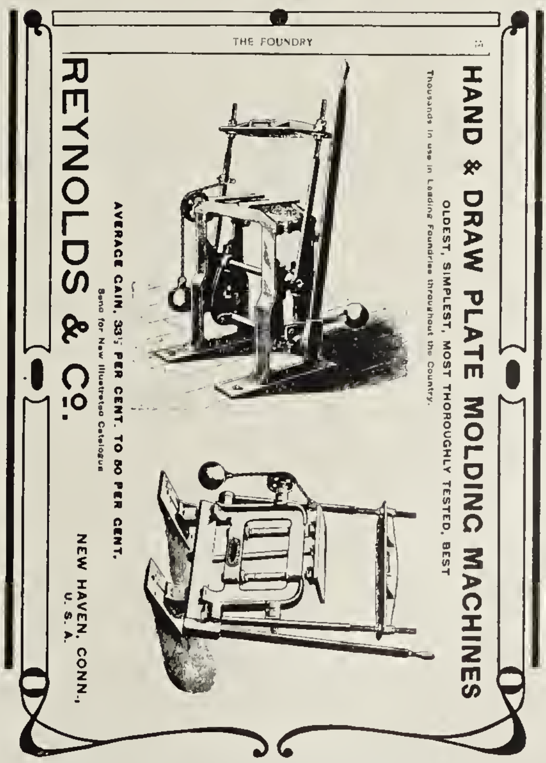
THE development of machine molding has been gradual, covering a long period. The follow-board which covers, or shuts off, from the sand that portion of the pattern above the joint line, was probably the first change from the original method of molding in boxes. The match-plate, which is a plate fitted with pins and pinholes for the flask, with a portion of the pattern fitted thereon like a medallion, came next. This was a greater improvement, for it compelled the flasks to be interchangeable. Silhouette, or stripping-plates, followed with decided advantage. The stripping-plate, often called drop-plate, is a plate cut out to receive the outline of the pattern at the joint line; enough is added to the pattern to protect through the plate to the pattern base. Like the match-plate it is fitted with pins and holes to receive the flask, it is also a molding table, or board on which the flasks are rammed. Originally, this plate was turned with the flask, and the pattern drawn through the plate by hand. Modifications of the stripping plate are numerous, nearly all embodying a frame or table, with lever attachment for drawing the pattern without turning the flask. A good illustration of this type is the machine for molding pulleys.

The evolution of the power machine from the hand machine was natural, and there are a number of excellent power machines on the market; operated, respectively, by belts and cams, hydraulic, pneumatic and steam pressure.

The one illustrated is manufactured and sold by The Tabor M'f'g Co., 111 and 113 Liberty St., New York

The particular machine from which these cuts were made is in use in the foundry of Samuel L. Moore & Son's Co., Elizabeth, N. J., making five different kinds of brake-shoes, two of which are of the Christie type.

It is at once evident to any one witnessing the operation of the machine that it is making shoes which are super-



THE FOUNDRY

HAND & DRAW PLATE MOLDING MACHINES

OLDEST, SIMPLEST, MOST THOROUGHLY TESTED, BEST

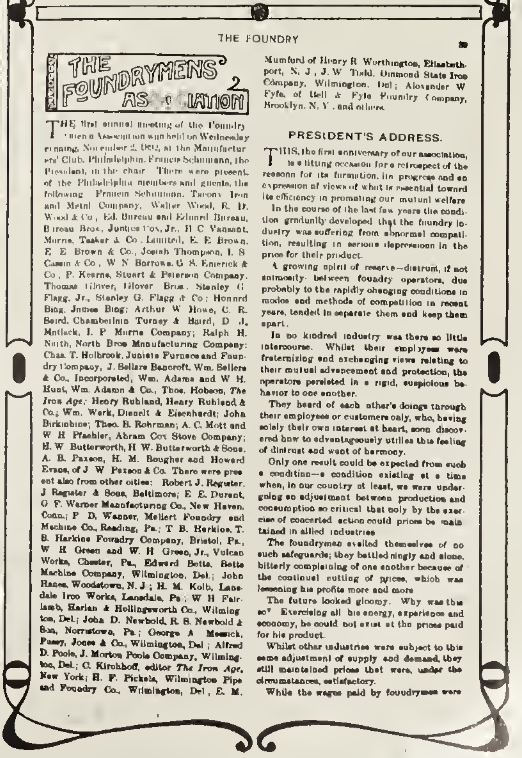
Thousands in use in Leading Foundries throughout the Country.

REYNOLDS & Co.

AVERAGE GAIN, 33⅓ PER CENT. TO 50 PER CENT.

Send for New Illustrated Catalogue

NEW HAVEN, CONN., U. S. A.



THE FOUNDRY 39

THE FOUNDRYMENS' ASSOCIATION

THE first annual meeting of the Foundrymen's Association was held on Wednesday evening, November 2, 1892, at the Manufacturers' Club, Philadelphia, Francis Schumann, the President, in the chair. There were present, of the Philadelphia members and guests, the following: Francis Schumann, Tacony Iron and Metal Company, Walter Wood, R. D. Wood & Co., Ed. Bureau and Edward Bureau, Bureau Bros., Justice Cox, Jr., H. C. Vansant, Morris, Tasker & Co., Limited, E. E. Brown, E. E. Brown & Co., Joseph Thompson, I. S. Cassin & Co., W. N. Barrows, G. S. Emerick & Co., P. Kearns, Stuart & Peterson Company, Thomas Glover, Glover Bros., Stanley G. Flagg, Jr., Stanley G. Flagg & Co.; Howard Bing, James Bing; Arthur W. Howe, C. R. Baird, Chamberlain Turney & Baird, D. J. Matlack, I. P. Morris Company; Ralph H. North, North Bros. Manufacturing Company; Chas. T. Holbrook, Juniata Furnace and Foundry Company, J. Sellers Bancroft, Wm. Sellers & Co., Incorporated, Wm. Adams and W. H. Hunt, Wm. Adams & Co., Thos. Hobson, *The Iron Age*; Henry Ruhland, Henry Ruhland & Co.; Wm. Werk, Dienelt & Eisenhardt; John Birkinbine; Theo. B. Rohrman; A. C. Mott and W. H. Pfaehler, Abram Cox Stove Company; H. W. Butterworth, H. W. Butterworth & Sons. A. B. Paxson, H. M. Bougher and Howard Evans, of J. W. Paxson & Co. There were present also from other cities: Robert J. Register, J. Register & Sons, Baltimore; E. E. Durant, G. F. Warner Manufacturing Co., New Haven, Conn.; P. D. Wanner, Mellert Foundry and Machine Co., Reading, Pa.; T. B. Harkins, T. B. Harkins Foundry Company, Bristol, Pa., W. H. Green and W. H. Green, Jr., Vulcan Works, Chester, Pa., Edward Betts, Betts Machine Company, Wilmington, Del.; John Hanes, Woodstown, N. J.; H. M. Kolb, Lansdale Iron Works, Lansdale, Pa.; W. H. Fairlamb, Harlan & Hollingsworth Co., Wilmington, Del.; John D. Newbold, R. B. Newbold & Son, Norristown, Pa.; George A. Messick, Pusey, Jones & Co., Wilmington, Del.; Alfred D. Poole, J. Morton Poole Company, Wilmington, Del.; C. Kirchhoff, editor *The Iron Age*, New York; H. F. Pickels, Wilmington Pipe and Foundry Co., Wilmington, Del., E. M. Mumford of Henry R. Worthington, Elizabethport, N. J., J. W. Todd, Diamond State Iron Company, Wilmington, Del.; Alexander W. Fyfe, of Bell & Fyfe Foundry Company, Brooklyn, N. Y., and others.

PRESIDENT'S ADDRESS.

THIS, the first anniversary of our association, is a fitting occasion for a retrospect of the reasons for its formation, its progress and an expression of views of what is essential toward its efficiency in promoting our mutual welfare.

In the course of the last few years the condition gradually developed that the foundry industry was suffering from abnormal competition, resulting in serious depression in the price for their product.

A growing spirit of reserve—distrust, if not animosity—between foundry operators, due probably to the rapidly changing conditions in modes and methods of competition in recent years, tended to separate them and keep them apart.

In no kindred industry was there so little intercourse. Whilst their employees were fraternizing and exchanging views relating to their mutual advancement and protection, the operators persisted in a rigid, suspicious behavior to one another.

They heard of each other's doings through their employees or customers only, who, having solely their own interest at heart, soon discovered how to advantageously utilize this feeling of distrust and want of harmony.

Only one result could be expected from such a condition—a condition existing at a time when, in our country at least, we were undergoing an adjustment between production and consumption so critical that only by the exercise of concerted action could prices be maintained in allied industries.

The foundrymen availed themselves of no such safeguards; they battled singly and alone, bitterly complaining of one another because of the continual cutting of prices, which was lessening his profits more and more.

The future looked gloomy. Why was this so? Exercising all his energy, experience and economy, he could not exist at the prices paid for his product.

Whilst other industries were subject to this same adjustment of supply and demand, they still maintained prices that were, under the circumstances, satisfactory.

While the wages paid by foundrymen were

ALSO THE FIRST MOLDING MACHINE DESCRIPTION AND ADVERTISEMENT, FRONT COVER, DECEMBER, 1892; ON PAGES

It is not unusual, even now, for a subscriber to notify us that he has every issue from the very beginning,

Never having missed reading a single copy.

Speaking of all parts of the world reminds us

That right now our foreign circulation, even in these war-disturbed times,

Is in excess of the entire paid circulation, as I remember it, during the first two or three years of our existence.

In this list England ranks first, Canada second, Japan third, Australia fourth, Scotland fifth, France sixth, Russia seventh, New Zealand eighth. Sweden ninth and

With the following in their order:

Italy, Spain, India, Holland, Norway, Switzerland, Argentine, China, Ireland, Denmark, British South Africa, Finland, Peru, Chile, Brazil, Tasmania, Dutch East Indies, Federated Malay States, Greece and Transvaal.

It will be noted that the Philippines, Alaska, Panama, etc., are not counted as being foreign countries.

And before the war, Germany, Austria-Hungary and even Turkey received a good many copies each month.

With some modesty it can be stated that the circulation today averages more than one copy to every iron, steel and malleable iron foundry in America.

Probably no other publication on earth so thoroughly saturates its field from a circulation standpoint.

I secured my first advertisement from Simon Obermayer, president of the S. Obermayer Co., Cincinnati.

I had a hard time seeing him as he sent out word that he was not interested in advertising.

But the bright-eyed office boy, whose acquaintance I made, helped me and I was so persistent and enthusiastic, that Mr. Obermayer gave me an advertisement

And the S. Obermayer Co. has had an advertisement in each issue since that bright day in 1892.

The office boy was the late Harry Frohman, who subsequently became the president of the company upon the death of Mr. Obermayer.

I think I had the friendship of both of these gentlemen until they passed away.

J. H. Whiting, of the Detroit Foundry Equipment Co., now the Whiting Foundry Equipment Co., gave me my second advertisement;

Thos. P. Byram of Byram & Co., Detroit, my third,

And others in their order are the J. D. Smith Foundry Supply Co., J. W. Paxson & Co., Huyett & Smith Mfg. Co., now the American Blower Co.; B. F. Sturtevant Co., Hamilton Facing Mills Co., Ltd., Buffalo Forge Co., W. A. Jones Foundry, Garden City Sand Co., Huessman Crucible Co., Columbia Brass Foundry, Chicago Foundry Supply Co. and Frederic B. Stevens, Detroit.

The second issue did not have quite as many advertising pages as the first—

The third even less,

But with the fourth, the experimental stage seemed to have passed and the increase set in that has been maintained ever since.

Incidentally, as proof that advertising pays, it can be stated that with only a few exceptions the advertisers in our first issue have been with us ever since and have grown and prospered,

As all our readers know.

THE FOUNDRY has had for its editors during the years of vicissitudes, Alexander Cairns, E. H. Pullman, Henry Hansen, Henry M. Lane and A. O. Backert.

Messrs. Cairns and Hansen have passed away

While A. O. Backert, while in charge of the editorial department has made a name and place for himself in many other directions.

Altogether, I believe that this publication has been the most vital factor in the wonderful transformation of the foundry business in the past quarter century.

From being an industry that was studied less, was the least efficient with the smallest and most inferior quality and quantity of labor-saving devices, where there was the most waste and the smallest general knowledge of the problems to be met each day from the buying of the sand to the mixing, melting and testing of the iron,

Of any established American industry—

None has developed more,

None has improved its processes more, and

None has accomplished more, considering the unscientific character of its operations in the early days.

But while the passing of time has made the changes necessary,

THE FOUNDRY was the constant inspiration of it all.

Its publication has brought me many friends.

Its influence for the best practice, high ideals and modern methods has been felt in every corner of the world

And the working out of it all has been the result of an iron molder's determination

To do something better.

THE FOUNDRY Parallels Iron Industry's Progress

By A O Backert

CONCURRENT with the period of the country's greatest industrial growth has been THE FOUNDRY's quarter of a century of existence. When the first copy of this publication made its appearance in September, 1892, pig iron was being produced at the rate of 9,157,000 tons annually as compared with nearly 40,000,000 tons today. The total steel output was less than 5,000,000 tons, against 42,773,680 tons last year, and iron ore was being brought down at the rate of 6,660,734 tons, whereas this year the shipments from the Lake Superior region will total nearly 60,000,000 tons. Unfortunately, no statistics are available of the extent of the foundry industry in the early 90's, but it can be assumed that its growth has paralleled that of iron and steel manufacture and thus today the casting production is five or six times that of 1892.

Labor-Saving Machinery Effects Economies

In the last 25 years the greatest strides in foundry operations must be credited to the labor-saving machinery introduced. Foremost of this equipment is the molding machine which has made possible the wonderful expansion of this industry. Elevating and conveying devices kept pace with the needs of these plants until today much of the arduous labor involved in mold-making and pouring has been eliminated. The chemistry of the business also has made wonderful progress, and while the most notable discoveries do not fall within the span of the last 25 years, nevertheless, this period marks their adoption and widespread application. From the purchase of pig iron by fracture and brand, the chasm to chemical analysis has been spanned and the physical properties of the foundry product today are of as much importance as the exterior appearance and conformity to pattern. Conservation of materials likewise has made headway, the cinder mill having been the means of recovering hundreds of thousands of dollars worth of metal for foundrymen. The most advanced step in the cleaning of castings is represented by the sandblast, which, in its various forms of application, not only effects great economies, but also surfaces the foundry output in a manner unobtainable before its introduction.

Every branch of the foundry industry has benefited from the development of the molding machine and perhaps the greatest progress toward the perfection of the various types has been recorded in the last 15 years. Although mechanical molding devices have been known for more than 100 years, it was not until the last generation that molding machine manufacturers applied themselves diligently to the solving of this great problem that marked progress was made. The jar-ramming principle was known before THE FOUNDRY was established, and although the first machine built by Charles Herman was crude, nevertheless it embodied the principle of packing the sand by the jarring principle. James Reynolds, Harris Tabor, Henry E. Pridmore, Wilfred Lewis, Charles Herman and E. H. Mumford were the pioneers who visualized the possibilities of labor-saving in foundry operations by the application of the molding machine, and to them the industry owes a debt of gratitude. Of this pioneer group, Wilfred Lewis, of Philadelphia, is the only one living.

Steel Casting Progress

Steel casting manufacture has undergone wonderful changes in a quarter century. In the early 90's the crucible process was at its height and feeble attempts were being made to increase output by the acid open-hearth. Basic practice followed in sections of the country where the raw materials for acid castings were high in cost and difficult to obtain, until today the tonnage of basic far outstrips that of the acid open-hearth. The side-blown converter, which possessed advantages in the production of small sections, not credited to the other processes, followed next and the output by this method now greatly exceeds that melted and poured from crucibles.

Introduced in the last decade, the electric furnace has made wonderful strides and the tonnage credited to this process in 1916 was nearly five times greater than that of the crucible shops. Electric furnace development is still in its infancy and its application to every foundry melting and refining process is predicted for the future. In the gray iron foundry, the cupola still is the most economical melting medium. Oil, introduced with coke, represents the latest step in the saving of fuel. The capacity of the cupola, however, has been greatly increased, until today those employed in pipe and car wheel shops, as well as for continuous operations, approach the blast furnace in size.

In the brass foundry many different types of furnaces have been introduced using coke, oil and gas for fuel. Some of these are operated successfully without crucibles, while others are designed to eliminate coke for fuel and still retain the graphite pot. The influence of the electric furnace already is being felt and several of this type already are in successful operation in brass foundries. The chemistry of alloying is better understood today than at any time in the last quarter century and in this branch of the practice great strides are promised in the next few years.

Malleable Casting Manufacture

The metallurgist and chemist have had a wonderful influence on malleable casting manufacture, with the result of greatly increasing the strength, elongation and application of this material. With the possible exception of capacity and method of operation, the air furnace has not changed in 25 years, and while the open-hearth is employed to a limited extent, its advantages evidently are not widely appreciated.

When THE FOUNDRY made its initial bow it announced that it was a "technical journal devoted to the foundry interests" and it has never departed from its original purpose. The corporation that established this publication was known as the Foundry Publishing Co., located at 172 Griswold street, Detroit, of which J. M. McFarland was president; S. E. Whitney, vice president and John A. Penton, secretary-treasurer. The first number contained 36 pages, of which 13½ were paid advertising, 20½ text and the remainder were devoted to the sale of books and announcements regarding the purposes of this publication.

The advertisers in the first issue consisted of the following concerns: S. Obermayer Co., Cincinnati, front cover; J. D. Smith Foundry Supply Co., Cincinnati, inside front cover; J. W. Paxson & Co., Philadelphia; Detroit Foundry Equipment Co., Detroit; Huyett & Smith Mfg. Co., Detroit; B. F. Sturtevant Co., Boston; Hamilton Facing Mill Co., Hamilton, Ont.; Buffalo Forge Co., Buffalo; W. A. Jones, Chicago; Garden City Sand Co., Chicago; Hussman Crucible Co., St. Louis; Columbia Brass Foundry, Chicago; Chicago Foundry Supply Co., Chicago; Frederic B. Stevens, Detroit, inside back cover, and Byram & Co., Detroit, outside back cover.

Among the foregoing whose advertisements have appeared without interruption since the first number, are the following: S. Obermayer Co., J. W. Paxson Co., Detroit Foundry Equipment Co., now the Whiting Foundry Equipment Co. and Frederic B. Stevens. This honor roll was added to in November, 1892, by Craig Ridgway & Son, Coatesville, Pa., and the Joseph Dixon Crucible Co., Jersey City, N. J. In December of the same year the Whitehead Bros. Co., New York, took the plunge in foundry publicity and has advertised continuously since that time.

The leading article in the first issue was written by Simpson Bolland and was entitled "Foundry Ovens". John Pettigew discused "Early Day of the Steel Foundry" and the consolidation of two foundry supply houses, located in Philadelphia, also was announced in this number. The firm of J. A. Emerick & Co., manufacturers of foundry supplies and equipment, of which John A. Emerick and Howard Evans, of J. W. Paxson & Co., were the sole owners, disposed of its business to J. W. Paxson & Co. Mr. Emerick retired from business while Howard Evans joined the Paxson forces, with which he is still connected.

The first reference to semi-steel is contained in the October, 1892, number of THE FOUNDRY, in which announcement is made of the manufacture of this material by the South Chicago Foundry Co. It was described as "a mixture with more than double the strength of the best gray iron" and that "while semi-steel is not a substitute for malleable iron, it is now in general use as a substitute for steel castings in all kinds of cars, crankshafts, rocker arms, crossheads, etc. Being of very fine texture and anti-acid in its properties, it is advantageously used in such work as smelting kettles, acid pans, etc." The claims made for this material at that time seemed to have been without limit, but its substitution for steel castings hardly would be recommended by the most ardent admirers of semisteel today.

Advance of the Steel Casting

In November, 1892, editorial reference was made to the growing use of steel castings and John Walker, of the Walker Mfg. Co., Cleveland, which plant now is owned by the Westinghouse Electric & Mfg. Co., ventured the following opinion regarding the growth of the steel casting industry: "Steel castings are taking the place of ordinary castings and forgings in a great many instances, especially in guns and gun carriage works, marine engine framing and bed plates, stakes for hydraulic riveters, large gears for cable railroad machinery, framing for hydraulic presses, punches, etc."

The first extensive foundry plant description appeared in the December number, the subject of this article having been the works of Henry R. Worthington, Elizabethport, N. J. E. H. Mumford was superintendent of this plant which was one of the largest shops in the country. This issue of THE FOUNDRY likewise recorded a marked increase in size with a total of 68 pages, as compared with 36 in the previous numbers. Among the new advertisers in this issue who have continuously appeared in THE FOUNDRY, is the J. S. McCormick Co., Pittsburgh.

This number also contained the first reference to molding machines in an illustrated article devoted to a power-operated, combination squeezer and stripping-plate. The piston was actuated by steam, although it was stated that either water or compressed air could be employed. The machine was manufactured by the Tabor Mfg. Co., Liberty street, New York, which has been succeeded by the Tabor Mfg. Co., Philadelphia. Machines of the squeezer type first were advertised by the James Reynolds Mfg. Co., New Haven, Conn., whose announcement was the first molding machine advertisement to appear in THE FOUNDRY.

Keep's Test

The first reference to Keep's test for cast iron was made in January, 1893, in an illustrated article written by W. J. Keep of Detroit. The first reference to the Teetor molding machine, manufactured by the Teetor Molding Machine Co., Indianapolis, was made in February, 1893. This machine lowered the mold away from the pattern and was mounted on wheels to facilitate its movement along the floor. An exhaust tumbling barrel was first described in March, 1893, in the advertisement of the Stover Mfg. Co., Freeport, Ill. This barrel was egg-shaped and was provided with an exhaust outlet at one end. The first power-driven sand sifter was referred to in April, 1893, this article having described a machine invented by John Walker of the Walker Mfg. Co., Cleveland.

The wonderful progress of the foundry industry was recorded from month to month in the advertising and reading pages of this publication, and the 300 numbers, of which this is No. 301, constitute a history of the casting art that reflects periodical development.

Gray Iron Progress in 25 Years

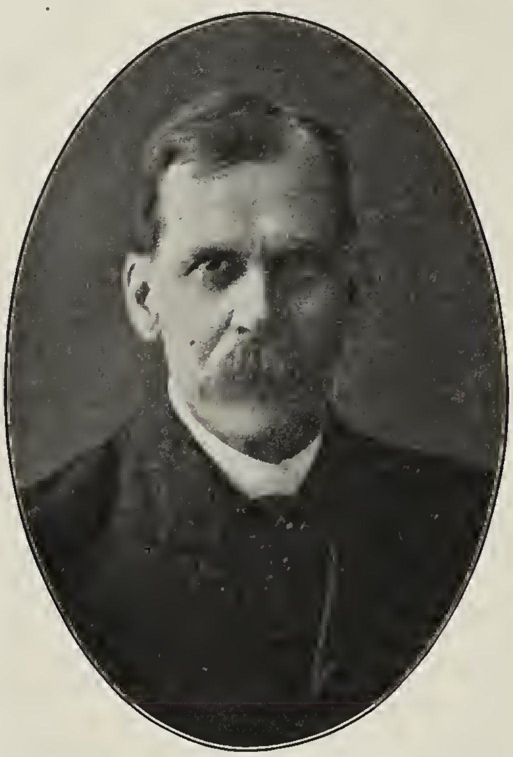
By W J Keep

TO GET a correct viewpoint for the beginning of this period we must go back about seven years. At that time the old eastern anthracite furnaces ran slow and with the same ore mixture all of the time. The manager lived close to the furnace so that he could be called any time a change was noticed in the slag, or in the action of the stack. The quality of the iron produced never was expected to change, giving a reputation to this *brand* of pig iron. Such brands as *Crown-Point, Hudson, Poukeepsie, Clove, Crane, Thomas and Bushong* were among the standard eastern foundry irons made in Nos. 1, 2 and 3 grades.

Peculiarities of Brands

Each brand had a peculiarity of its own. Each founder had a mixture that suited his purpose and never changed. He used imported Scotch to enable him to carry scrap. The western coke furnaces, as a rule, did not acquire the reputation for individual brands that was enjoyed by the eastern furnaces. The hard Lake Superior ores did not make as good foundry iron as those mined in the east, even when mixed with soft, local ores. Western furnaces were accustomed to make *Mill, Bessemer, Malleable and Foundry* irons in the same furnace and when a change was made there were several days in which *off* irons were produced.

Soft lake ores soon were discovered which made as good foundry iron as any of the eastern ores. The great red fossil ore deposits of the south, mixed with brown ores near at hand, produced the best foundry iron that had ever been made, and the furnaces ran regularly so that the brands always were dependable. Western founders used *Ohio Softeners* as a scrap carrier, which were more effective than Scotch pig.



W. J. KEEP

No one could tell why one iron was better than another. All pig iron was sold on its reputation and fracture. I once asked the most successful founder in the east for the secret of his iron mixing. He said that the makers of the brands of iron that he used knew what he wanted and set aside piles of such iron. About twice each year he would visit the furnace yards and have several pigs from each pile broken and would mark for shipment the piles that suited him. He said that he knew what would make good castings, but could give no reason for it. Another great iron master and foundryman said that when he was about to make a large casting he selected from his iron yard about three times as much pig as he would use, of the different grades, and melted each grade separately in a cupola and cast it in a regular pig bed. Each pig was then broken and he selected the iron that seemed to him to be suitable for the casting.

The usual foundry troubles were hard spots, chilled edges, blow-holes and shrinkage cracks. These were ascribed by furnace managers and chemists to silica (glass) and to sulphur. The manager of the largest marine engine shop in Cleveland said of his foundry foreman: "I would call Mr. Blank out and tell him about those hard castings, and complain about them." "Well," he would reply, "It is the confounded sulphur in the last lot of coke we got." Fluorspar and patent fluxes were used to counteract these evils. Many founders sold their remelt, and I knew of one stove foundry that accumulated in one year 400 tons of remelt which, it was believed, could not be used.

Effect of Silicon Learned

In 1885 Prof. Thomas Turner, of England, discovered that by varying silicon the grayness and hardness of a casting could be changed at will. Later, in the same year, I discovered that the measure of shrinkage of a test bar was a *mechanical analysis*, showing whether more or less silicon was needed to keep the shrinkage and silicon uniform. In 1886 Prof. Turner stated, "We are still in need of exact information as to the influence of sulphur, phosphorus, and maganese in cast iron." This research was begun at once in America and the results are recorded in the *Transactions* of the American Institute f Mining Engineers, 1888, 1889, 1891 nd 1893. The testing committee of the merican Society of Mechanical Enineers followed with physical results hich are recorded in their *Transacions* of 1894, 1895, 1896, 1898, 1900, 901, 1904, and 1905. The testing comittee of the American Foundrymen's ssociation made many investigations, hich likewise are recorded in their *ransactions.*

It took several years for the pig on makers to learn that silicon was eneficial. As early as 1892 some furaces were selling iron by an analysis f silicon and sulphur, but when they id so, they refused to be responsible or the fracture or for the results in elting. They held that the founder ust take the risk if the fracture was lose and irregular, which it was sure be. The founder, however, was not nxious to purchase iron by analysis nd would not yield to this, and insted on a good fracture. The furace chemist soon found, that with re, the furnace could be run so regurly as to produce an open fracture r No. 2, with a closer grain as silicon ecreased. The furnace salesman of ch iron educated the founder in the use of silicon and how to make his mixtures. He also advised him to ask the advice of a chemist and to have his castings analyzed.

Instead of blaming coke for every mistake of the foundry foreman, it was purchased by analysis. The result was that laboratories were located at various points to help the founders.

Analysis Control

Today every furnace analyzes everything that goes into the stack and mixes the ores to produce exactly the irons that founders require, and a card, giving the silicon and sulphur, is sent with each carload of pig iron. The founder, who understands mixing, can purchase any grade of pig, and can mix other irons with it to produce the quality he needs. He is not tied down to any special brands. Iron mixing is now an exact science. The modern pig iron maker is liable to run his large furnaces too fast, not allowing enough time for the absorption of carbon. Silicon controls quality by its action on carbon which should be 3.25 to 3.50 per cent. Machine or chill cast pig is not yet very common in this country, but is nearly universal in Europe. The absence of sand makes a clean cupola. The fracture shows exactly the kind of a casting it will make, as any inequality in grain or tendency to chill will be shown by the fracture. Judging by fracture can return again when all pig is chill cast.

The strength of a casting is not entirely dependent upon its chemical composition, but also upon the physical structure of the grain. Experiment will show which of the available pig irons will increase strength. Pig irons for imparting silicon are made in various parts of Ohio and at some other points, from ore which will produce nothing else. Six per cent silicon is about the lowest made and is the most economical. The founder should always have a car of high silicon iron in his yard to use in an emergency, but it is better to get the silicon in the ordinary pig iron. In melting iron, scrap should be broken as small in size as the pig iron, and charging should be uniform, to make the blast equal through all parts of the charge. Riddle out all dirt so that none shall be charged into the cupola. Every cupola should be slagged and analyses made to ascertain whether the limestone flux contains pyrites.

Progress in Foundry Equipment Manufacture

By J H Whiting

FEW foundrymen realize what wonderful progress has been made during the past quarter century in the design d construction of foundry equipent. In the pioneer days, if a new iece of equipment was needed, the perintendent or foreman asked the atternmaker to produce the model, have the castings made and to ssemble a machine by the aid of a w rough sketches. In the early 's practically all new equipment was uilt at home. Today, however, the perintendent reports his requireents to the purchasing engineer, ho asks for bids from companies ecializing in the particular equipent to be installed.

The Continuous Cupola

As in the past, the foundry must perate daily. The cupola must be ady for tomorrow's heat. All of esterday's castings must be cleaned d out of the way. This is present d past history. We are now comg to a new era. Instead of a pola melting eight hours daily, we ow are asked to design and build iniature blast furnaces, the bottoms which are dropped after continuous ns of 120 hours or more. The demand is for continuous rather than daily operation, and the ingenuity of the engineering departments of the equipment builders are taxed to the limit to keep pace with the needs of the industry, which constantly become more exacting. Special cupolas for continuous operation have been developed and more than a score already are in use. Individual outside tuyeres is the principal feature of these designs.

For several years there have been insistent demands for new labor-saving devices. History and present conditions warn us of a labor shortage that will last for years after the end of the war. Labor shortage is accompanied by high wages and plant engineers are seeking to eliminate the human factor wherever possible. The cupola charging machine is one of the most wonderful labor-saving devices that can be introduced in foundries producing 50 or more tons daily. These machines, with proper yard and charging platform layout, will reduce the number of men required from 18 to six. On the present wage basis a saving of 12 men for 300 days per year yields a handsome return on the investment. I have been informed that a certain installation of charging machines paid for itself in wages saved in less than two years.

Considerable progress also has been made in the designs for corebaking equipment. The drawer type oven, now in wide use, was introduced only within the last decade. Its extensive adoption for day baking indicates how it met a practical need.

The First Tumbling Barrels

The first tumbling barrels were crude, home-made affairs, but they have been developed into a first-class machine and might be classed among the machine tools. In many cases tumblers are employed in 24-hour service, which is more severe than that imposed upon any machine tool ever built. Tumbling mills are built in more than a dozen different types to meet the particular needs of the purchaser. In size they range from 18 inches round or square by 3 feet in length, to 84 inches round or square by to 10 to 12 feet in length. A single order has been placed for as many as 60 heavy duty steel plate exhaust tumblers for one foundry.

A forward stride in safeguarding health was marked by the introduction of the cloth screen dust arrester.

Mill room conditions of 25 or 30 years ago would not be tolerated today. The proper cleansing of the air by passing it through a cloth screen arrester is indispensible in the modern foundry and is specified by statute in many states.

Crane equipment, perhaps, has undergone the greatest change and is the most important factor in economical operation. The fully-enclosed, dust-proof construction of conveying machinery with its sensitive control apparatus is a big factor in keeping things moving in the busy foundry. Magnet cranes are used for unloading and handling pig and scrap; bucket cranes for unloading and storing coke and sand, and they also may be used for cutting molding sand; electric travelers for the efficient and quick handling of heavy castings and flasks and jib cranes on the side floors for handling small molds, and in the main bays to relieve the overhead travelers. A jib crane in the core room often will enable the same gang to produce 25 per cent more cores per day than otherwise would be the case. Only general features have been touched upon in this review; to attempt to cover all the details of the long list of equipment on the market today would take many pages. I have endeavored to show that in the foundry equipment business, as in other industries, hit-or-miss methods are being replaced by operations based on careful studies of service requirements and actual results. No doubt the next 25 years will witness even greater progress in castings production.

Malleable Iron Improves in Quality

By Enrique Touceda

PROGRESS recorded in the manufacture of malleable cast iron within the past few years has been such as to cause favorable comment by engineers and manufacturers who use these castings in large quantities on machines where the dependability of each working unit is the first consideration. It is undoubtedly true of the history of every industry, the success of which is dependent upon a knowledge of chemistry and metallurgy, that progress is slow, erratic and practically inconsequential, until the scientific principles involved are well understood by those directing the work. Even with this knowledge as an aid, it is not always an easy task to accomplish, in a commercial manner, all that is desired in the way of uniformity and quality of product, for it is obviously impossible to secure the services of scientists to operate metallurgical apparatus under working conditions, both arduous and trying, while large furnaces cannot be controlled with the exactness and nicety that is possible under laboratory conditions.

Prior to 1914, so far as I am aware, no serious attempt had been made by any body of manufacturers to carry on a systematic investigation of the malleable iron process. During that year some 30 different companies, acting jointly, decided that the time had arrived when it was necessary to fall in line and emulate the example of those who in other branches of manufacture had long since discovered such a policy essential and indispensible to advancement. Thereupon it was decided to establish chemical and physical laboratories and to spare no reasonable expense in securing what scientific data were necessary to hasten the solution of their problems and the improvement of the quality of their product. Briefly, the work undertaken covered the following: A study of the reactions that take place in the air furnace and a determination of the allowable limits of the different constituents in the mixture within which it was possible to obtain a hard iron casting such as would yield a superior quality of product, and the influence exerted by the different elements in relation to ductility, toughness and strength; a thorough investigation of the reactions that take place in the annealing oven and the effect of the different constituents on the conversion of the hard iron into the annealed product.

ENRIQUE TOUCEDA

Uniform test bars for tensile and impact test were adopted and everything in this connection standardized in order that the same kind of tests would be conducted at each plant, thereby making possible not only a comparison of the quality of product made at one plant with that made by any or all of the others, but in order also that any customer desiring information as to the uniformity and quality of metal made at any plant would find this information available and obtainable immediately upon request.

Air furnace and annealing oven construction has been studied and improved and apparatus has been installed that makes their operation and control more perfect. In recent years makers of malleable castings have devoted considerable time to the study of the elimination of shrinks in castings of intricate design, or disproportionate sections and that great progress in this direction has been achieved can be vouched for by the fact that not only are many thousands of these castings used yearly in the automobile industry, but the demand for them has steadily increased.

Accompanying the decision to perfect all details of the manufacturing end of their business came the equally important determination to perfect their cost-accounting practice. To this end the services of one of the most experienced accountants in the country was secured, through whose efforts an accurate and dependable cost system has been developed and introduced in each plant. In so far as possible the hazard of chance has been eliminated, and systematization and advancement is a slogan that has been followed faithfully. The foregoing is presented because it carries with it the explanation for the healthy and promising improvement in malleable casting production in the last few years.

Operating a commercial laboratory and being in close touch with many foundries we have had occasion in the past 25 years to make many physical tests of malleable iron. As these test bars varied in section, some having been round and others square or rectangular, a fair comparison cannot be made with what is being done today. Examining the records of these tests, it is seen that the average ultimate strength falls quite a little under 39,000 pounds, while the elongation scarcely averaged 3.50 per cent. Occasional bars showed a very high strength, but in rare cases was this strength accompanied by what we would consider to be fair ductility as measured by the elongation; in other words, in the days referred to, it was not known how to obtain high strength combined with ductility, failing which, high strength is of but little value. I do not wish to be understood as stating that prior to 1914 there were no malleable iron foundries making an excellent and satisfactory product, but it is true that those that did were comparatively limited in number, so limited, in fact, as to have no influence in altering such averages as I have given. Let us now see what results other investigators have obtained at certain intervals during the period referred to.

Records of Other Investigations

I have a copy of an article written by Prof. P. C. Ricketts, published in Van Nostrand's Engineering Magazine, Vol. XXXII No. 4-20, in which he makes record of numerous tensile tests. In order to economize space I have totaled his tables and furnish their average ultimate strength and elongation only. The first table contains a record of eight bars, a full ¾-inch square in section; the average ultimate strength and elongation is 39,821 pounds and 5.60 per cent, respectively. The second table contains the results of four bars that are a scant ¾-inch square in section; the average ultimate strength and elongation of these is 32,580 pounds and 2.10 per cent, respectively. The third table contains the results of seven bars approximating 1 x ⅜-inch in section, the average ultimate strength and elongation of which are 34,467 pounds and 2.40 per cent, respectively. The fourth table contains the results of nine tensile test bars, a full ½-inch round, the average ultimate strength and elongation amounting to 39,101 pounds and 3.50 per cent, respectively. The fifth table contains the results of 13 bars, a full ¾-inch round, whose average ultimate strength and elongation amount to 34,040 pounds and 1.50 per cent elongation.

I also have in my possession the copy of a thesis of which Francis Blake and Max Miner of Sibley College of Mechanics Arts, Cornell University, are the authors. The introduction to the thesis is as follows: "This series of tests was made in the hope of obtaining a set of reliable values for the strength of malleable cast iron." They have made a very complete examination covering, as did Professor Ricketts, the determination of the elastic limit, ultimate strength, elongation, reduction of area, modulus of elasticity, etc., but as in the former case I quote merely the ultimate strength and elongation:

The tensile tests were made on four bars which measured a full 1 inch in diameter; the average ultimate strength and elongation is 39,375 pounds and 4.48 per cent, respectively. In this thesis they quote an article descriptive of the malleable iron process written by Dr. W. F. Durand for *Marine Engineering*. I have selected these few sentences from the article quoted, which indicate that the ductility of malleable iron must have been very low in the days in which this article was written: "Attention may be called to the ductility of malleable iron, which is from four to six times that of cast iron though only about one-tenth that of wrought iron."

A glance also at the many specifications introduced in the past will demonstrate the fact that low strength and ductility has been the general thought in connection with the physical properties of malleable iron.

Progress Highly Encouraging

Within the past three years we have made many thousands of tensile and impact tests on bars of uniform dimension as specified by the American Society for Testing Materials in their specifications for malleable iron castings. The results of these tests have all been tabulated and conveniently classified, from which we find that in the year 1915 over 94 per cent of the bars exceeded 40,000 pounds in ultimate strength; in 1916 over 97 per cent and thus far in 1917, over 98 per cent exceeded that figure. In 1915, 51 per cent exceeded 46,000 pounds ultimate; in 1916, 73 per cent and thus far in 1917, 76 per cent exceeded that figure. As a matter of fact, in 1917, almost 20 per cent of the bars exceeded 52,000 pounds ultimate and these had an average elongation in round numbers of 15 per cent. During the past two years we have received a large number of bars whose elongation approximated 20 per cent; a fair number in the vicinity of 24 per cent and one bar had an actual elongation of 27.34 per cent, showing that there are possibilities that research may yet find a way to make a cast product like malleable iron equal in physical properties to such hot-worked material as wrought iron.

A consideration of the foregoing facts surely not only justifies one in stating that great progress has been made in this industry within the past few years, but in predicting that study and thought is bound to continue to make itself felt in the direction of steady and continuous progress.

Progress in Malleable Iron Manufacture

By J P Pero

NO REVIEW of the progress made by the foundry industry in the past 25 years would be complete without giving credit to THE FOUNDRY for the part it played in promoting the wonderul advances recorded. I have watched he growth of THE FOUNDRY from its irst issue to the current number and am convinced that the progress made y this publication accurately reflects he advance in foundry practice in that period. Prior to 1892 a few of the trade journals devoted more or less space to articles on foundry practice, but not until the advent of THE FOUNDRY did we have a trade journal devoted to our interests.

That the field has been well covered is attested to by the wonderful growth of this journal; in fact the interests of the shop and the journal are so closely allied that it is hard to imagine either progressing without the other. In the malleable branch of the industry today we are even more reticent in expressing our ideas in the technical journals than were the gray iron foundrymen 25 years ago. The literature on malleable practice is so limited that it never has had a place in the curriculum of the technical schools. Graduate engineers take up practical work well equipped with a theoretical knowledge of gray iron and steel, but they know nothing about malleable cast iron. Only in the past few years have a sufficient number of papers been presented before the American Foundrymen's Association to justify special sessions for the consideration of this topic exclusively which is done today. Probably the largest malleable castings produced are those used in the construction of freight cars and automobiles. From personal observation I have concluded that not until recent years and until the advent of the highly specialized gray iron foundries built for the production of automobile castings, did the gray iron approach the malleable foundries in their efficiency of molding and coremaking practice. I believe that the early development of the molding machine was fostered by the demands of the malleable industry in the production of castings for agricultural implements.

Advent of the Air Furnace

The substitution of the air furnace for the cupola for melting iron marked a new era in malleable practice. While the introduction of the air furnace antedates this 25-year period, it is well within this span that air furnace practice became general. Seth Boyden used a small air furnace in his foundry in Newark, N. J., and others of small capacity later were erected, some of them with a capacity of only 1000 pounds. When a capacity of 2 or 3 tons had been reached, it was conceded that this was the limit. In 1880, the late Benjamin J. Walker, of the Erie Malleable Iron Co., Erie, Pa., and A. E. Hammer, of the Malleable Iron Fittings Co., Branford, Conn., concluded that there was practically no limit to the capacity of the air furnace provided the lines and proportions of these small type were retained. Beginning their experiments with a 3-ton furnace, by degrees they enlarged it until they were melting 15 tons per heat. Eventually Mr. Walker built and successfully operated a furnace of this type with a capacity of 40 to 50 tons. These experiments were made with furnaces using natural draft.

In the meantime others had increased the capacities of their furnaces by using forced draft. The improvement in the quality of the metal from the air furnace led to the adoption of this process, until today only a comparatively small tonnage is melted in cupolas.

Chemistry of Malleable Iron

In 1878, Mr. Hammer began an investigation of the chemistry of malleable iron, and to quote his exact words he found he "was in an unknown country". After a year's work on the problem, he discovered that the production of *black-heart* malleable depended upon a certain balance or equilibrium between the carbon, silicon and manganese contents. For a long period the varying percentages of sulphur in his mixtures prevented him from reaching definite conclusions, but eventually he determined upon a chemical analysis of pig iron which, under ordinary conditions in the cupola or air furnace would produce so-called black-heart malleable iron.

Reaumur, the eminent French chemist, in 1872 nearly reached a correct conclusion of the chemistry involved in making malleable, but his deductions were based upon crucible practice.

It is my belief that Mr. Hammer was the first to solve the chemistry of the malleable process. As a result of his research and experiments, and the confidence he had in his determinations, he made experiments in 1879 in charging anthracite and coke irons as substitutes for charcoal iron; he soon learned that he could produce high grade malleable iron with these grades by adhering to well-defined chemical specifications and by melting in an air furnace. Thus we find that mixing and melting malleable iron in a little more than 25 years has advanced from the cupola with its charge of charcoal iron and sprue, to the air furnace and open-hearth with mixtures of coke iron, sprue, malleable and steel scrap.

Nor has the annealing process been overlooked in the progress of the last quarter century. Comparatively few changes have been made in the construction of annealing ovens. The most important of these were made for the purpose of securing a more uniform distribution of heat, with economy in the use of fuel as desirable, but secondary consideration. From the ordinary coal-fired oven, types have been evolved using natural gas, producer gas, pulverized coal and oil for fuel. The adoption of the pyrometer marked the beginning of uniform annealing. This instrument has been of incalculable value, both to the control of the oven temperature and as an aid in determining changes in construction to secure uniform temperatures. For many years mill scale and borings were used for packing material in the annealing pots and in bed ovens, and until a few years ago it was considered necessary to enrich the packing by sprinkling it with a solution of acid or of sal-ammoniac, thus adding oxide.. This packing was highly offensive to the employes of the annealing room and its discontinuance proved pleasing to them. The packing now generally employed consists of the slag skimmed from the metal. It is first put through a cinder mill, the shot iron extracted, and occasionally it is enriched by the addition of mill scale or borings, thus making it a satisfactory packing material.

Malleable Iron Ideal Metal

The nature of malleable cast iron makes it ideal for purposes requiring strength and ductility, while its absolute immunity from crystallization under vibratory or other shocks places it in a class by itself among the ferrous metals. These features, combined with its comparatively low cost, have created an ever-increasing demand for its use in freight car construction, automobiles, agricultural implements, etc., and it is not unreasonable to assume that the progress, both in the manufacture and in the use of malleable iron in the next 25 years will be greater than in the last quarter of a century.

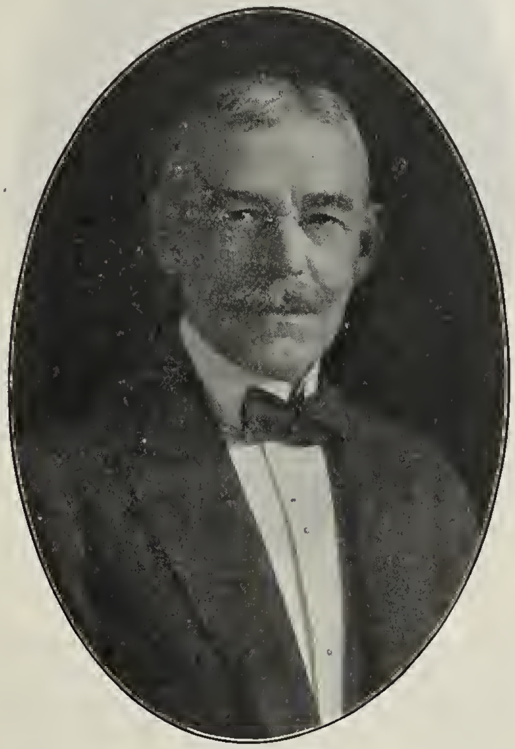
Growth of the Foundry Supply Business

By Frederic B Stevens

TO CLEAN one's memory house, to make more clear and distinctive the mental accumulations of 25 years is not altogether an easy task. It is not unlike looking down from the mountain top when trying to discern each individual mile post, each of importance when on the upward journey, but seemingly inconsequential when reviewing the panorama below. The view carries even beyond the starting point, so it may be more than 25 years that here in the central west, the foundry supply houses most in evidence were the Van Tuyl Facings Mills, and the genial "Tom" Kelly was their traveling missionary; afterwards, and perhaps even during the early part of the last quarter century, there was established the firm of T. P. Kelly & Co., and the senior member of that firm still continued his visits until the time of his death.

Simon Obermayer, of the S. Obermayer Foundry Supply Co., also was a welcome visitor in those days, and among other things, concealed in his capacious coat pockets, and which he displayed to each possible buyer, is a chamois-skin packet, containing olders' tools, slicks, spoons, etc. ter taking a large order he never led to present the shining array, for r. Obermayer despised not the day, r the sale of small things, which aracteristic, doubtless, had much do with laying so good a founda- n for so large and prosperous a siness, as is evidenced today by e corporation still bearing his name.

Another necessary item of foundry pplies was Albany molding sand, n apparently controlled by the White- ad Bros., and it is probable that name *Albany Sand* was rather ore indicative of its source than now implies, for it now is mined er a wide area, extending as far as ratoga, N. Y., and in these latter ys, implies a kind, or a quality, her than a locality, for we some- es hear of *Ohio Albany Sand*. At at time the firm of J. D. Smith Co., Cincinnati, was an ambitious al for foundry facing business and mprised J. D. Smith and the Fitz- orris brothers. The senior mem- r's two sons then were clad in ickerbockers and were as much in- ested in the game of *shinney* as y have since been in the manufac- e of foundry supplies. Somewhere those early days, the winter of content seemed to have pervaded souls of two successful salesmen the S. Obermayer Co., known to buying trade as John Hill and m Griffith, and that combination of youthful ambition, plus some hard-earned savings, gave birth to the Hill & Griffith Co. John Hill now is head of the Hill-Brunner Foundry Supply Co. and Tom Griffith died about a year ago. The Cleveland Facing Mills, too, were in evidence, and George P. Millns was their manager and salesman. Thomas D. West at an earlier date was connected with that corporation, but later he conducted foundries of his own, and until his death was a prolific writer of molders' text books, covering a wide range of foundry practice. I believe that the foundry supply business is largely indebted to Messrs. Obermayer and West, for they really were pioneers and they did much to develop the business.


FREDERIC B. STEVENS

The growth of the foundry supply business was aided and accelerated in large measure by a then restless young man, once a machinery molder at Houghton, Mich., who had an ambitious desire to part with the sand heap. While publisher of the *Machinery Molders' Journal*, at Detroit, he conceived the idea of a publication devoted exclusively to the foundry trade, for which he contended there was a field since no such journal at that time was in existence. He then interested some of his friends in this project, including a lawyer, an insurance agent, a school teacher and the writer, and so THE FOUNDRY was born with John A. Penton as its editor and publisher. During its youthful career it had its vicissitudes and there were times when the ghost walked—so did the printer—but the indefatigable energy and tireless labor of the Penton brand was back of it all and if the baby edition could be placed beside the present number ocular proof would be presented of just what that energy signifies. Also, if the advertisements in that infant edition could be compared with those in this number one would quickly realize how the foundry supply business, like Topsy, "growed".

How Gray Iron Has "Grown" in 25 Years

By Alexander E Outerbridge Jr

THERE is perhaps no more striking evidence of the progress that has been made in the foundry industry during past quarter of a century than is wn in the growth in size, circulation importance of THE FOUNDRY. Start- in a very modest manner 25 years , I recall distinctly my surprise, on eiving the initial number, that anyone uld have the temerity to begin such enterprise in view of the fact that e were already several trade papers ing to cover a wider field in the i and steel industry that were striv- to compete with each other for scriptions and advertisements from ndries. The obituaries of several of e journals have appeared from time ime, but THE FOUNDRY has flour- d and has grown in the arid soil of foundries, from a weak sapling into iant tree, spreading out its branches l it now covers every field of the iron, steel and brass foundry industry. The natal year of THE FOUNDRY 1892, was a banner year in the production of pig iron; over nine million tons (9,157,000) were made, being more than three million tons (3,219,839) greater than the average of the four preceding years and more than one million tons (1,194,169) greater than the average of the four succeeding years. Then, in the year 1897, the production of pig iron for the first time approached closer the ten million mark, which was passed by a good margin in the following year, since which time production has increased by leaps and bounds, until now it is more than four times that of 1892.

So much for the total output of crude pig iron in the United States during the past 25 years.

What progress has been made in the manufacture of pig iron into finished material during that time?

First and foremost, of course, comes for consideration *steel* in its various forms, and alloys of steel, some of the more important alloys having been created and developed within the period of time named; but as the request which I have received from the editor of THE FOUNDRY to prepare a brief paper specifies "the progress that has been made in the gray iron industry," I must eliminate all consideration of steel products in this paper and confine myself to gray cast iron.

Twenty-five years ago the doom of one of the most distinctive American cast iron industries was generally pronounced. I refer, of course, to the manufacture of chilled cast iron car wheels.

The advent of the 30-ton car, with its load of over 10,000 pounds on each wheel, taken in connection with the increased speed of trains, was commonly thought to necessitate the retirement from service of the cast iron wheel on the doublescore of safety and economy and the substitution of the cast or forged wheel. Indeed, for a time, it seemed as though this prognostication would surely come true, but the reverse has happened.

Fifty-ton cars made their appearance some years ago with cast iron wheels having twice the load per wheel of the 30-ton car and the end was not reached! It was recently stated by the president of the Railway Club of Pittsburgh that the chilled iron wheel has not only shown successful performance under half a million 50-ton cars, but has even passed the experimental stage under 70-ton cars. The same authority states that there are 25,000,000 chilled cast iron wheels in service, representing 8,000,000 tons of metal, requiring an annual production of 3,000,000 wheels, or approximately 1,000,000 tons of chilled iron to replace those worn out in the service.

These figures are impressive and indicate that the purely American invention of the chilled cast iron car wheel is still able to more than hold its economic importance in the iron industry of the country. More interesting details might be given on this topic, but the space allotted to this discussion will not permit of further consideration. Passing on to the subject of gray iron for foundry castings we find that great advances have been made all along the line.

ALEXANDER E. OUTERBRIDGE JR.

The composition of pig iron and the relation between its composition and its physical properties have been studied from various angles and the old rule-of-thumb methods of mixing iron have now given place to scientific procedure.

Eliminating *chill* from iron by chemical means has permitted the casting of gray iron which can be readily machined in permanent metal molds. These castings have many peculiar and valuable distinctive properties which castings made in sand molds do not possess, such as increased density, extremely fine grain, increased strength, absence of draw holes or sand pits, etc.

Twenty-five years ago the molding machine was in its infancy and small castings only were attempted; now, large castings weighing thousands of pounds are made on jarring machines with unskilled labor in a fraction of the time required to make the molds by hand and skilled labor. The duplicate castings thus made vary much less in weight than do similar castings made in molds rammed by hand.

Science has stepped into the foundry and has cast out many old superstitions giving new life to the gray iron industry as well as to all other branches of the foundry trade and the future has many improvements in store.

Malleable Foundry's Quarter Century Survey

By Richard Moldenke

THE malleable casting occupies a unique position in the general iron industry. It is useful as such only when produced within a comparatively narrow range of composition, and subjected to high and long continued temperatures chosen equally as careful. But little improvement, therefore, may be expected even in a quarter of a century, and then only in the details of the operating end.

Until comparatively recent times, the malleable foundryman only knew that when he took No. 2 charcoal irons, melted them in crucible, cupola and air furnace to yield hard, white fracture castings, that these, when heated for nearly a week while packed in an oxidizing medium, would—if kept at red heat for fully three days of that time—result in soft, malleable castings showing a *black-heart*. Today he knows why he has had to do these things and consequently can replace the charcoal irons by cheaper metal, besides avoiding the failures due to variations in the mixture, defective melting practice and annealing in regard to which he was formerly helpless.

The beginning of light in the malleable foundry dates from the knowledge that silicon is the controlling factor of the mixture, and it has taken the past 25 years to implant this fact firmly in the minds of the foundrymen interested. Practically every malleable man knows, therefore, what silicon his mixture must carry to bring out correctly the class of work he makes. Unfortunately, however, the chemistry of iron is not the only thing to consider, as the *physics* of the metal also plays an important part, so that the pig-scrap relation, the melting process and the duration and temperature characteristics of the anneal must also be carefully watched by the producer of malleable castings to insure success.

Developments Summarized

The developments of the past 25 years therefore, may be given in the following: The making of mixtures on a chemical basis and with due regard to the physical condition of the metal required; that is to say, the foundryman will have settled for himself the percentage of pig and scrap he may carry in his mixture, the scrap to consist of definite proportions of the foundry sprues and discounts, steel and malleable scrap. One of the great developments for safety has been in this direction. When the percentage of sprues made is very high—as for instance in extremely small work, where it may go up to 75 per cent and particularly where cupola melting is practiced—the sulphur climbs to unsatisfactory limits. If all the sprues are used it is a question of only a short time when the castings cannot be properly annealed for *black-heart* work and the European *white-heart* material must be aimed for, with all the troubles, defectives and expense this entails. With the advent of chemistry in the foundry, however, it has become possible to watch the sulphur in the daily work for the allowable maximum, and thus hold the mixtures to the right sprue proportion. Formerly it was necessary to periodically sweep the sprues out of the foundry and begin anew with straight No. 2 pig.

Again, the higher the scrap percentage the greater the annealing risk. It seems as if the metal will not properly open up, as it were, to allow the deposition of the *temper-carbon* in small patches scattered among the crystalline iron structure. This also applies to the steel and malleable scrap additions to the mixture, which have a powerful effect on the ability of the metal to anneal and upon its quality when properly receptive to the annealing process. These things, as stated, the foundryman ows or should know if he has folwed the advance in the malleable lustry. Therefore, he may sit in his ice, lay out the melting program to e for his stock of pig iron on hand, illeable scrap that he must take by y of business exchange, and be absoely certain that if melted right, the stings will go into the anneal with ery chance of coming out as firstss malleable.

Introduction of Chemistry

The introduction of chemistry has iieved another result in the malleable indry. It is no longer necessary to expensive charcoal pig iron—ough this is still desirable if obtaine at comparatively reasonable figures. e foundryman has learned that the lling qualities of charcoal and coke ns are identical, everything else be- equal. Hence there has been no iculty in replacing charcoal by wellde coke irons. The *well-made* atoute of coke irons needs a word of olanation. Charcoal irons can be de in the furnace with silicon down 0.10 per cent and still remain unoxzed to an extent that malleable casts with 0.35 per cent silicon, for ich some of this extremely low sili- metal has been used, will be firstss. In the case of coke irons, vever, any metal with a silicon below 5 per cent is almost certain to be dized, to have more sulphur than it uld and will be generally weak. erefore, it has been found necessary hold the castings above 0.65 per cent silicon, and to do this without danger m gray fractures in the hard casts, steel must be added to raise the ezing point of the metal and thus the white fractures required before pieces go into the anneal.

ince, however, the last 15 years e brought about a considerable nge in the malleable casting industry eel having replaced most of the vy-sectional work—the low silicons former times have given way to ier ranges and higher percentages of l and malleable scrap in the mix-. This introduction of coke irons the malleable foundry and the reement that the coke irons used must of the highest quality, meaning eby the absence of oxygen and low hur, has called for an entirely new le of iron, namely bessemer malle. In the early days of coke iron he malleable shop it was found that mer pig with the phosphorus *off* good results. In other words, if maximum of 0.100 per cent phosrus allowed in acid bessemer prac- was exceeded and it could not e that steel process, the iron could be used in making malleable cast-. It was also found, however, that malleable castings were only good

RICHARD MOLDENKE

when the iron was normally made, and not a true *off* iron due to furnace troubles. As a result, a great range of ores, just a little too high in phosphorus for steel became available for pig-making, commanding a premium over ordinary foundry irons which carry perhaps three times as much phosphorus. All such bessemer malleable pig irons are well-made *honest* pig irons, or must be so to retain their standing in the malleable trade.

Introduction of Steel and Malleable Scrap

In addition to the change from charcoal to coke irons, the introduction of steel and then malleable scrap into malleable mixtures form a development of the past 25 years. In this direction, however, the old saying that "a little knowledge is a dangerous thing" comes into play. Malleable men who found that adding steel to the mixture gave them castings with better bending qualities, as well as greater strength, followed this line of practice too far with the result that their shrinkage problems were increased also. And not only this situation resulted, but the contraction of the castings became so variable that in the standard specifications in use (another comparatively recent development) the allowance for variation of casting from pattern dimensions had to be increased. This is not a good development.

When the steel scrap addition to the mixture is looked at from another angle, namely the use of up to 60 per cent steel in cupola mixtures, a situation results which is not complimentary to the malleable industry. How often has it happened that in discussing the policy of using so much steel with an enthusiastic foundryman doing this very thing in his own shop, and who wished to prove his faith by sending for his own castings from stock, that the first blow of the hammer has set the pieces flying about? True, good castings can be made that way, but they are *white-heart* in the first place, and run up to 0.20 per cent in sulphur, and the most interesting fact is that the total carbon of the hard casting is over 3 per cent. In other words, such material is unreliable and so far as composition is concerned, is surpassed considerably by air furnace iron with far less scrap steel in the mixture. Only the ordinarily low price of steel scrap is the cause of such hybrid developments. These, as well as the product of short anneal methods either die early, breaking their sponsors financially, or the castings are delivered to some industry which is not exacting in its requirements, or is asleep.

On the other hand, the judicious use of steel and malleable scrap, with the best of melting practice—preferably the use of the open-hearth or electric furnace—has resulted in magnificent material, the tensile strength, elongation, transverse strength and deflection of which comes so near to good steel that the foundryman is tempted to enter fields of work he had better stay away from on general principles. He rarely produces such good material day in and day out without sometimes encountering difficulties.

One of the desirable developments of the past 25 years, which has not been exploited as it should have been, is the use of the open-hearth furnace. Considering the fact that the castings made by this melting process are far cheaper than air furnace work—in fact, almost as cheap as cupola castings and far better—the conservatism of the malleable man is evident. A number of open-hearth malleable plants are operating successfully today, and the disastrous results in one large plant in the early days which made the atrocious mistake of attempting to operate without regenerating the producer gas used as well as the air, should not be held up as a warning to those looking into the matter.

Electric Furnace For Malleables

The latest development, that of the electric furnace, is being watched with considerable interest. Whether the particular application is the best remains to be seen. In general, it should be remembered that no matter what the melting process is, the fact remains that by far the greater portion of heat which has to be imparted to iron is used to bring the metal up to the point of melting, the smaller amount going to the actual melting and superheating. If, therefore, the mixture can be heated up to white heat by comparatively cheap means—as in a soaking-pit with regeneration of air and gas—and then introduced into the electric furnace for melting and superheating under the more expensive conditions of current consumption, the very best results are bound to follow. This idea, therefore, is commended to the malleable industry as a decided development of the next 25 years.

The development of the malleable foundry as a business has been tremendous, the last quarter century having witnessed the doubling of a production that had been close to 500,000 tons per annum at the beginning of that period. The malleable industry is bound to grow even more, the capacities of today being greatly behind the demand. Only the fear of an uncertain future to follow the great cataclysm of today is hindering new building operations, but eventually these are bound to come, and with them labor-saving machinery to solve this problem also.

With this development in view, a proper understanding of the problems of the malleable foundry should be the basis of the necessary planning. Fundamentally, in both the gray iron and the malleable foundry, melting should be done with as little refining as possible. It is desirable to take from the furnace, as nearly as possible, that which has been put in. If, therefore, some method by which heat is imparted to the charges just short of melting is arranged for, and for such a situation suitable charging machinery can be installed readily, the labor problem is cared for, since the hot, solid metal can be introduced easily into the electric furnace by machine. This furnace will melt, correct sulphur and oxidation troubles, allow additions and generally care for the making of an excellent superheated material ready to go into the molds, and will go into them without the terrific rush of pouring an air furnace heat. The melting end of the malleable foundry would then become similar to the melting department of the steel mill, with all its means for economy and tonnage production. The molding machine should care for the future of the molding floor.

Annealing Practice

In annealing development but little has materialized these last 25 years. The usual number of attempts along lines of short annealing periods, special kinds of packing, high temperature ranges, etc., have been made with the usual disastrous results. Most of these attempts were based upon the teachings of laboratory results on very small samples. The investigators did not seem to realize that the critical temperatures of the laboratory electric furnace necessary to bring about the carbon changes in the metal were much higher than the actual temperatures these castings in the saggers of the annealing oven required when given far more time. In other words, where the laboratory chemist found that a piece of *hard* malleable needed 1550 degrees Fahr. to anneal in his furnace, the works chemist found that the same result would be accomplished at 1350 degrees Fahr. with the continued period of application of daily practice.

With all the developments mentioned as occuring these last 25 years, the fact remains that these have been entirely aolng the lines of establishing the principles underlying the production of malleable castings, and taking advantage of this knowledge to improve and standardize the product. The general process itself has not been changed from what it was at the time of Reaumur for the European malleable, or of Boyden for the *black-heart*. The limits of composition as well as limits of temperature for annealing are too close to allow much variation, for when these are overstepped, the product is no longer the malleable casting.

Supplying the Foundryman for 25 Years

By John Hill

JOHN HILL

WHEN John A. Penton launched THE FOUNDRY 25 years ago, he obtained expressions of opinion from foundrymen and supply and equipment manufacturers throughout the country, regarding the advisability of starting a publication of this kind. This issue reflects the measure of success it has attained. It has proved helpful to the foundry supply business, since it places the manufacturer in close touch with the foundry trade throughout the world.

Few people realize the importance of the so-called *foundry supply game*. At least 90 per cent of the devices invented to facilitate foundry operations have been introduced into casting plants by the supply man. A number of foundry supply dealers sell molding machines, but all of them handle every line of equipment, with this exception, for the modern casting shop.

Whether or not they get credit for it, the foundry supply manufacturers have saved the foundrymen of this country a great deal of money. Wheat and oil are selling at such high prices that their use is almost prohibitive in foundry plants. Through their ingenuity and resourcefulness, the foundry supply men have perfected various substitutes to replace flour, rosin and other raw materials, which today are commanding unusually high prices. As a matter of fact, many of the substitutes represent improvements over the materials which they replace and they are sold at about one-half the cost.

Few foundrymen realize the importance and extent of the seacoal facing industry. At least 400 tons of coal are ground daily for this purpose and when the coal barons advanced the price of coal to unheard of heights, the facing manufacturers sold their product at a price below that quoted for run-of-mine coal. As a matter of fact, the foundry supply manufacturer not only can be considered the benefactor of the foundry industry, but in fact, a philanthropist. He is constantly working in the interest of the industry which he supplies, yet, history does not record the endowment of a college or the *spotting* of a library by any member of a firm engaged in the foundry supply trade.

Before the war, practically all grinders obtained graphite for plumbago facings from the island of Ceylon which enjoyed the reputation of producing the finest materials obtainable for foundry facing purposes. As the result of embargoes, curtailment of shipments and increased freight rates, Ceylon graphite was more than doubled in price and it was up to the foundry supply men to ve the difficulties which then con- onted the foundry trade. With all eir resourcefulness they investigated : situation and today they are supply- ; the trade with plumbago that will ke good castings, at practically the ne prices asked for facings before war.

In the early days of the foundry sup- trade, the supply salesman was given le consideration. In my long ex- rience as a salesman, it has been my vilege, many times, to cool my heels hours in the offices of some works, aiting an audience with the purchas- ; agent. In one instance, three pig n salesmen, one coke salesman and insurance agent were permitted to cede me. These gentlemen could not derstand why they had the preference er me and when ushered into the purchasing agent's office, they apologized for preceding me, to which the purchasing agent replied, "he is only a facing salesman, let him wait." Time, however, has brought about many changes and the foundry supply salesman now is welcomed in every foundry.

Many of the foundry supply houses operating at the present time carry extensive stocks which include everything used in the foundry, from a wooden wedge to a cupola. It has been my experience that the foundryman will not anticipate his needs and it is necessary for the foundry supply house to carry immense stocks to take care of his every requirement.

One of the perplexities of the foundry supply business is that practically all of the trouble resulting in casting losses, is blamed on the supply man. As a rule, the difficulty is attributable to poor facings. Most of the supply manufacturers employ chemists who analyze the raw materials and who also supervise the making of the mixtures. In addition, practical men are employed by the foundry supply houses, who have the ability, and who are always willing, to render every assistance to their customers to aid them in securing the production of sound castings.

The foundry supply fraternity has been an important factor in promoting the success of the American Foundrymen's Association and its annual exhibitions. In view of the relation of the foundry supply salesmen to the foundrymen, the casting manufacturers should have emblazoned on the tombstones of everyone of these cheerful trade solicitors, "he was a good fellow."

Progress of Steel Founding in 25 Years

By R A Bull

THE subject named above is much more interesting as a matter for reflection than it is satisfactory to describe in brief resume. The developments of ; industry in the last quarter cen- ry have been so great and its attrac- ns for young men are so pronounced, at most of those who are today en- ged in making steel castings knew thing of the art 25 years ago. To mmarize every interesting phase of ; growth of the business in the period ntioned is beyond the ability of the thor of this paper. Nor can he safely empt to chronicle the most impor- it developments in their proper con- cutive order and he will only discuss me of them, sketching briefly a few their applications.

Progress in Furnace Construction

The extensive use of a basic bottom open-hearth foundry practice has aracterized the last quarter century of ogress. The largest steel foundries ve been built in that period, and ny, being located where material mar- ts warranted their choice of a basic ing, have employed it with great suc- ss. This has been made possible large- through the concurrent manufacture d intelligent use of alloys, of which per cent ferrosilicon is the better own, enabling the steelmaker to better oxidize his metal. Today first grade sic steel castings are made in enor- ous quantities.

Open-hearth furnace construction has ide many advances. The tilting fur- ce is the most striking modification iich came into existence in the period der discussion. It has not, however, realized the hopes of its ingenious originators, and now seemingly has no chance to displace to any great extent, the original stationary type. Roof and port construction, and checker design have experienced much scientific development, following the use of new combustibles, such as fuel oil and powdered coal. The combustion of the last named in the open-hearth is the latest novelty to be introduced, and offers to the investigator greater opportunity for experiment than did fuel oil which was quickly found to be most easily adapted for steel melting, and much superior to producer gas.

R. A. BULL

Several types of charging machines have been developed in recent years, resulting in reduced charging periods and heavier production. Coincident with these improvements came better valve construction, automatic devices for signalling and recording the reversals of valves, water-cooled ports and door frames, specially designed pyrometers, rapid analytical methods for the laboratory, and numerous other details whose effect in securing the good results now obtained is important, but a complete summary of which is here unnecessary. The need for them has offered a fertile field to engineers and scientists.

Side-Blown Converter

With the improvement attending open-hearth construction and manipulation have come novel types of melting units, the first of which to be introduced in this country being the side-blown converter for foundry use. Its application soon became quite extensive, when it was seen that the installation was relatively inexpensive and that this vessel was well adapted for intermittent use, the production of very hot metal required for pouring thin sections, and making small quantities of steel of special composition. Several modifications of the first accepted type have had successful campaigns.

From Europe came to us, after the development of the foundry converter, our most novel unit for making steel—the electric furnace—of which arc and induction types have been successfully produced. Whereas previously the engineer and the metallurgist supplemented the knowledge gained by the practical foundryman, now the electrical engineer came to the front to help perfect the art. The development and introduction of the electric furnace have in the last decade been most interesting. It has superseded many converters and crucible furnaces, despite its high installation and fuel cost. The use in this furnace of the lowest grades of melting stock, and the greater refining possibilities have made it very desirable in some localities for certain classes of work. The electric furnace has attained a permanent status which has not appreciably detracted from the favor in which the open-hearth is still held. The improvements in details of construction are constantly taking place.

A natural result of development in furnace construction has been the better opportunity for making manganese steel and other alloy steel castings which in the past 25 years have been made in increasingly greater quantities, some containing elements unknown in steel in 1892. This has been a specialized and most interesting phase of the growth of the steel foundry industry to which we can here only briefly refer.

Pouring steel in green sand molds has been one of the most important details of foundry practice which came into its own in recent years. The foundries in the middle west must be given the credit for applying this method of steel molding in a large commercial way. It has been of tremendous advantage in overcoming shrinkage troubles, increasing production, and otherwise reducing foundry costs. The practice will make much greater advancement in the future as its advantages become more widely recognized, and as the effect of a small amount of moisture in a mold which is properly vented ceases to be exaggerated. In the last two decades, cast steel bolster and side-frame manufacture has assumed very large proportions which would never have been possible without the use of green sand molds. The railroads have been among the chief consuming beneficiaries.

Molding and Coremaking

Molding and coremaking methods in the steel foundry have made much progress, as in the founding of other metals. Pneumatic and electric jarring machines, pneumatic sand rammers, improved types of stripping and roll-over machines as well as gravity machines, pushers and squeezers have all been tried out in the steel shops, and many of them have been there used with good results. More satisfactory designs of sand mills and sand conveying machinery are constantly being worked out, applicable to steel foundry use. For many years the core room did not keep pace with the progress of the molding floor. Within the last 10 years its development has been very rapid, and has inspired to great activity the ingenuity of those who are perfecting methods for handling and drying cores, which processes are no less important than their economical ramming. With improvement in core room practice has naturally come the greater application of the core itself to molding.

The compounding of materials and the use of by-products to give molding and core sands their adhesive quality has been of very great importance in the last 25 years. It is only within the present decade that the manufacture of dry binders has been conducted by men who, considered as a class, have realized the folly of selling the foundryman cheap and in some cases, useless materials whose function often seemed to be to disguise a high-priced mixture. Steel foundrymen in recent years have learned many pertinent truths about sand binders, and are not easily misled.

Pyrometric control of annealing, pneumatic chipping hammers, the use of gas in burning-off risers and in welding, the employment of the electric arc in the latter operation, the use of grab buckets for cleaning floors, and of lifting magnets for handling melting stock, the development of specialties, devices for safety, equipment for comfort, and methods for the better co-operation of employes, have all attended operations in recent years in steel as in other foundries. Much of this growth was absolutely unheralded 25 years ago. Progress made in steel founding during the past quarter century has been of tremendous extent compared with prior development. It seems safe to predict that the next 25 years will far overshadow what we have attempted here to briefly summarize as a past performance.

Semisteel in the Last Quarter Century

By David McLain

IF John A. Penton, a molder by trade, had not had a vision of great possibilities for a foundry trade paper—if he had not persevered in devoting all his energy to his publication, even at a great personal sacrifice—probably this twenty-fifth anniversary might have been postponed indefinitely.

Oldtimers, the writer included, remember distinctly some of the difficulties that confronted Mr. Penton in the early days, but none were so discouraging as the hardships worked by his own craft. Practical men who had been working at the trade for years thought little could be gained from such a trade paper, as they claimed Mr. Penton was only a molder, not an editor.

But what an example of perseverance is reflected by the twenty-fifth anniversary of this publication! Mr. Penton was right and many others were wrong.

I have been asked to write about semisteel, but at the same time I hope I will be pardoned for reviewing the improvements in metallurgical processes in the iron foundry business during the past 25 years. In fact, to one like the writer who has been on the firing line for more than 40 years, it appears as if there has been 100 years' advancement within the past quarter century.

To the late Thomas D. West the American foundry industry is so greatly indebted that it should erect a monument in his name to commemorate his wonderful achievements. He was *another molder* whose efforts started many foundrymen thinking along the right lines when he published his book entitled *The Metallurgy of Cast Iron*.

The advance in the art would have been still more rapid if some one had written a companion book on "Good Cupola Practice", but evidently this was left severely alone by those competent to melt iron scientifically.

In the early days the ratio of cupola area to tuyere area was not understood, and in many instances the cupola area was 20 to 30 to 1 of the tuyere area, with two, three and four rows of tuyeres; experiments have proven that the best tuyere area, in proportion to the cupola area, is confined within very narrow limits, and *one row of tuyeres is sufficient*.

The coke to iron ratio averaged 6 and 7 to 1, but today from 8 to 10 to 1 on medium heats, and up to 12 to 1 on long heats, is quite common, although the Connellsville coke used in those days was equal to, in fact, superior to, some of the cokes being sold today for much higher prices.

The melter was a law unto himself, as the cupola was but little understood and its workings were considered mysterious; this continued until we learned the proper tuyere area, the exact amount of coke to use on the bed and between the charges for different sized cupolas, the proper amount of iron on the bed, etc. Until we could take down satisfactory heats every day, instead of only *sometimes*, it was practically impossible to melt steel scrap in large quantities the production of homogeneous, ma-inable castings of light section.

Fifteen years ago the wrrter com-eted experiments and announced to e Milwaukee Foundrymen's associa-on that a *new metal* was discovered. ince we used about one-third steel and lded ferromanganese in the cupola ereby gaining 40 per cent transverse rength over the best grade of gray on and reduced the casting losses, e called the metal semisteel and have en doing so ever since.

Practical Knowledge a Drawback

How was the announcement received foundrymen? Like other new ideas, was considered a *fake,* of course. The riter also was a molder, who worked through the business to foundry anager, and the word *practical* seemed stand for *drawback* among the fra-rnity. All but a few had previously rown some steel turnings or borings to the ladle of iron or preheated steel rap or placed it in the bottom of the dle before tapping; this was called misteel, but frequently it was of no e whatever, and hence was called mething else.

After the writer was through experi-enting with semisteel, he had a strong sire to help broaden the practical an's knowledge of better foundry ork. He began to teach foundrymen ee of charge and did so for many years fore offering the information to the ade in the form of a scientifically ar-nged course of instruction. The first nouncement of this course appeared THE FOUNDRY in 1908, and for some ne was looked upon with suspicion foundrymen; evidently many miscon-rued my intentions and were laboring der the impression that I intended teach *molding* by mail, instead of actical metallurgy, the results of my ars of successful experimenting in any shops. They could not conceive w it was possible for a practical undryman to acquire the necessary owledge of metallurgy to do this.

Foundrymen did not take kindly to e idea of learning to mix irons by alysis, which they were compelled to before receiving the semisteel formula, r by this time they believed that all at was necessary was to throw some el scrap into the cupola and they d semisteel. Of course, not under-nding the fundamental principles gov-ning the melting of steel in the cu-la, the resultant metal was far from ing the *real* semisteel, and hence was ndemned.

For many years old Scotch foremen d used steel scrap to make hard or ite iron and laughed at our claims semisteel for thin and medium sec-ns. Today some foundrymen still im that steel scrap will not improve ir product, but the majority of foundrymen know better and every year adds converts to this wonderful metal.

Prior to 1902 the writer can find no record where steel scrap and good foundry pig would reproduce any mixture in which charcoal pig had been thought essential. That one achievement alone marked a milestone in foundry progress and was so considered by the pioneers who had used high carbon charcoal pig iron for years. In fact, they believed they could not operate without it.

At that time all text books, whether by technical or practical men, maintained that steel reduced carbon. Chemists and metallurgists agreed that it was not a good thing to use; that steel would not mix with iron; that steel caused hard spots; that a higher melting temperature was necessary, and that manganese was a hardener because of the accepted theory that it converted graphitic carbon to combined carbon, etc.

DAVID McLAIN

The use of steel in cupola mixtures was questioned on all sides, but much doubt was set at rest when it was proved that carbon would be absorbed from the fuel by the steel up to the saturation point; that manganese, above a certain point, aided in increasing the saturation point of iron for carbon, since steel fuses perfectly as it has a strong affinity for carbon, silicon, sulphur, phosphorus and manganese, proving to the metallurgical world that steel improved the product and that a new principle was discovered and applied with astonishing results.

The writer does not claim to be the first man to use steel in cupola mixtures, but no previous record has been found relating to the use of large percentages of steel scrap in castings of light section.

When properly made, semisteel, in both temperature and fluidity, exceeds any other mixture melted in the cupola. The oxidation of the steel, when melting scientifically, is scarcely perceptible; when the steel is heated in the presence of the coke it begins to absorb carbon from the fuel, faintly at low temperature, but as the temperature increases and the steel and coke become incandescent, the steel absorbs large percentages of carbon and no longer is the steel of commerce, but a highly carbonized metal and *will melt before the pig iron in the same charge.*

No record could be found of how much manganese should be in the mixtures for certain castings, but our steel foundry experience has taught us that the percentages necessary to produce the best and strongest steel castings, so we began at that point and increased the percentages with surprising results.

At that time the average iron foundryman apparently did not care whether there was manganese in his pig iron, as the claim that manganese was a hardener led foundrymen to believe it was a good thing to leave out of their mixtures.

The writer has produced machinable castings of light section with 30 per cent steel and containing 2.25 per cent manganese. As we have insisted on high manganese pig, and have advised our friends to do likewise, it is now possible to obtain pig iron with from 1 to 4 per cent of manganese.

We also learned that high manganese with high phosphorus pig produced a superior quality plow point when used with 20 to 30 per cent steel scrap, and that steel additions enabled the automobile, gas engine and other cylinder manufacturers to produce better cylinders of lighter sections with lower casting losses.

Within the past decade the stove founder is using waste steel clippings and makes stronger, cleaner castings with lower losses. Steel improves the quality of piano plates, agricultural castings, car wheels, radiators, shrapnel, projectiles, acid, ammonia, furnace, die and general jobbing castings; in fact, steel improves all castings that must be subjected to hydraulic or other tests, or where a certain high transverse or tensile strength is desired. Every conceivable iron casting is improved by steel scrap when used by men who know how to mix by analysis and to melt intelligently.

Increased Transverse Strength

I have increased the transverse strength of soft gray iron for light sections from 2000 to 3000 pounds by the addition of only 10 per cent of steel and have increased the transverse strength of gray iron for heavy castings from 2500 pounds per square inch up to 4000 pounds and more by the addition of 30 to 50 per cent of steel scrap. This certainly is ample proof. Formerly it was customary to use chills on the V-ways of lathe beds inside of large cylinders, etc., but semisteel of the proper density is preferable and has satisfactorily replaced chills except for car wheels and rolls.

While the foregoing are achievements that have been recorded since THE FOUNDRY. was first published, the majority have taken place within the past 15 years. The writer predicts that in the next five years chromium, nickel, manganese, etc., will be used to produce better semisteel, as I already know that we are on the verge of some interesting metallurgical developments. I look forward to the time when semisteel castings will be made that will yield a tensile strength of 50,000 pounds per square inch without annealing and 65,000 pounds and over when annealed. The reason many foundrymen have not manifested more interest in semisteel is because they do not understand the laws governing the melting of steel in the cupola. When they begin to understand this they will realize that the cupola is the heart of the foundry and every progressive foundryman not only will believe in semisteel, but he will make it and profit greatly thereby in the improved quality of his castings.

What the Brass Foundry Has Done in 25 Years

By Charles Vickers

CONSIDERABLE progress has been made in the brass foundry business during the time that THE FOUNDRY has been on the scene and much of it is traceable directly to the efforts of the founder of this publication, aided and abetted by those who have taken time from sand pounding to let other foundrymen know what was in their minds.

When the last quarter of a century was young, the adoption of means for the comfort, safety and convenience of the employes seldom was considered. Today, however, the ventilation of the plant is of prime important when a new foundry is designed. Formerly the brass foundry was an undesirable place to work in, as gases from the furnaces filled the shop to the great discomfort of the operatives. This condition sometimes was regarded as inseparable from the proper conduct of the business. In one large foundry that melted about 100,000 pounds of metal per day 20 years ago, blast-driven, hard coal-fired furnaces were installed under the same roof as the molding floor. As the furnace flues were inadequate, the gases of combustion were driven in clouds from underneath the furnace covers and filled the shop with fumes. In winter, when the shop windows and sky-lights were closed it was not unusual for the molders to have headaches and some became so sick they could not return to work for several days. While the difficulty in this case was due to poorly designed furnaces, it was aggravated by housing them in a long, narrow, low building, with the furnaces in one end and the molders in the other. The result was that in both winter and summer, the windows and doors had to be kept open to let out the gas. In winter, the employes suffered from the cold and in summer the heat was almost unbearable, due to the low roof. The defect could have been remedied at little cost by enlarging the furnace flues.

In a shop that specialized in phosphor bronze, it was the foolish custom to add the phosphorus to the metal after the pot had been taken from the furnace. Seven pounds of yellow phosphorous were added to each pot of 300 pounds of bronze by the simple expedient of tossing the phosphorus from a water-filled can to the surface of the molten metal, stirring after each addition with a long, iron bar. Two men devoted themselves to this pastime.

It must not be assumed that all brass foundries, even 25 years ago, were poorly ventilated, unsanitary and unsafe. Another foundry of that period, which specialized in plumbers' and steam fitters' brass goods was located in a large, roomy building, with a high roof and had plenty of light and ventilation. Fifty molders and coremakers were employed, the latter girls who were separately housed and were provided with all the conveniences one would expect in a modern foundry. For the men, neither wash rooms nor lockers were provided. Everyone carried the dirt of the foundry into his home.

Wash Rooms and Lockers

In one large city where the molders were well organized they demanded that washing facilities and lockers be installed in the brass foundries. After the surprised employers had recovered from the shock of this request they cheerfully provided washing and locker facilities.

The progress that has been made in improving the working conditions of foundry employes has been worth while as it has proved beneficial to all engaged in the production of castings.

The alloys in the production of which there has been no improvement are those that have been known for centuries, including the copper-tin, copper-zinc and copper-lead series. The alloys in which progress has been recorded are the modern bronzes such as manganese and aluminum bronze, and strides also have been made in the casting of aluminum alloys. We have a greater knowledge of the peculiarities of these alloys, with the result that no great difficulty is now experienced in making castings from them of any required size. If a manganese bronze casting is unsound and requires patching, such as burning-on to cover up the defects, then its life is uncertain and is liable to be terminated at any time by season cracking. The cause of this phenomenon is unknown.

While some measure of progress undoubtedly has been made in the art of brass founding in the past 25 years, candor compels us to admit that it has not been quite as startling as it might have been, considering the attention the business has latterly received in a technical way. Anyone who has visited many brass foundries is impressed with the scrap piles which are still with us. Spongy castings, blown and misplaced cores, washed sand, and parts forgotten, still figure largely as the causes of our unsuccessful efforts to shape metal in sand. Castings still continue to be returned by the purchaser, perhaps because they leak, are too rough or fail to check up with the patterns.

While we have more tools to work with and more *expert* aid, than in years gone by, the brass foundry owner is not getting rich any faster than formerly, nor is less skill required by the molder.

Some progress has been made in casting aluminum and copper alloys, but it is not sufficient to attract much attention. A few years ago the casting of manganese bronze was regarded as quite a problem, due to the fact that the alloy possesses what might be termed an *honest* shrinkage. Such a casting, insufficiently fed by metal from some external source, such as a riser, will show shrinkage cavities and depressions on its surface and proving beyond question that it is defective. In the case of the copper-tin alloys, however, while the shrinkage is there just the same, it is concealed and does not show on the surface of the casting. Before the modern bronzes were known, comparatively small risers were used to feed brass castings and it was

THE FOUNDRY DATA SHEET, SEPTEMBER, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

FORMULAS FOR THE BRASS FOUNDRYMAN

Aluminum Alloys

One of the most extensively used alloys of aluminum is what is known as No. 12. It consists of aluminum and copper. The usual proportions are copper, 8 per cent and aluminum, 92 per cent, but it is not unusual for the alloy to be softened by reducing the percentage of copper to 7, and sometimes to 6 per cent, the aluminum being increased in proportion to the decrease in the percentage of copper.

The best method of making this alloy is by the use of a hardener composed of equal parts of copper and aluminum, as follows:

	Pounds
Copper	50
Aluminum	50

Melt the copper under a cover of fine charcoal, and when thoroughly liquid, add the aluminum gradually, in small pieces, and between additions, stir with an iron bar coated with alundum cement applied as a wash and afterwards dried. Have the stirrer hot before dipping into the molten metal. Add the aluminum no faster than the copper will dissolve it without being chilled partly solid, and after the addition of all the aluminum, remove immediately from the furnace and pour into ingots. Do not allow the hardener to reach a bright-red heat before removing it from the furnace.

When cold, the hardener will be rather brittle and no difficulty will be experienced in breaking it into pieces suitable for making weights.

To make the 8 per cent aluminum-copper alloy, or regular No. 12 aluminum, melt together the following proportions of hardener and pure aluminum, in a crucible of suitable size:

	Pounds
Pure aluminum	84
Hardener	16

If a softer alloy is required, smaller percentages of hardener may be added.

Great care always must be exercised in making alloys of aluminum if good results are desired. This involves constant supervision throughout the melting process. A bright red heat is always dangerous to aluminum, because being so chemically active, it attacks the materials of which the crucible is made; merely rubbing the sides of the crucible with the stirring rod frequently will start a reaction, the result of which is always harmful to the alloy. The temperature of the metal, therefore, should be kept no higher than a dull red, approximately 800 degrees Cent.

While thin castings require pouring at a temperature of about 800 degrees Cent. in many cases to insure proper running, this is too high for castings of thick section. The latter should be poured no hotter than 700 degrees Cent., and below this temperature if possible. Hot-poured aluminum castings will be porous, as indicated by black spots. At a red heat aluminum greedily absorbs the steam generated by contact with the moist sand, at the same time decomposing it and combines with the oxygen to form alumina which is a white solid. It retains the lively hydrogen in the form of minute bubbles which are disseminated throughout the mass of the casting.

The Foundry, Data Sheet No. 241, September, 1917.

FORMULAS FOR THE BRASS FOUNDRYMAN

Aluminum Alloys

An alloy of aluminum, zinc and copper, employed extensively for automobile work, follows:

	Pounds
Pure aluminum	79
Aluminum hardener	6
Zinc	15

The specific gravity of this alloy is 3.10; the tensile strength is as high as 25,000 pounds per square inch and the casting qualities are good.

The following aluminum alloy also is frequently used:

	Pounds
Pure aluminum	65
Zinc	35

The specific gravity of this alloy is 3.30 and its tensile strength is in excess of 30,000 pounds per square inch.

The following alloy has good casting qualities and possesses about the same tensile strength as the alloy previously named:

	Pounds
Pure aluminum	70
Aluminum hardener	7
Zinc	23

A good, white alloy, suitable for pattern plates, follows:

	Pounds
Pure aluminum	79
Aluminum hardener	4
Tin	2
Zinc	15

Another alloy suitable for the same purpose as the foregoing, follows:

	Pounds
Pure aluminum	80
Aluminum hardener	10
Tin	10

When melting aluminum alloys the pasty dross that occasionally forms on the surface of the metal can be removed by the addition of a small piece of fused zinc chloride. The effect of this chemical is to cause a reaction which effects a separation of the dross and entangled metal, the former being liberated in the form of dust.

The Foundry, Data Sheet No. 242, September, 1917.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

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natural that the same methods should be applied to manganese bronze before the peculiarities of this alloy became known. Under the name of steel bronze the alloy was used extensively for making sprocket wheels for bicycles and it seems ludicrous now that this trouble should have been experienced in making such simple castings. Truly, we have made progress in this direction in the past few years.

When the light aluminum alloys were first introduced, much difficulty was experienced from the cracking of the castings in the molds. This probably was due to the selection of unsuitable alloys and to the fact that the molds were rammed too hard. Too much zinc also was used in the aluminum alloys with the result that the metal was susceptible to cracking. Large quantities of sprocket wheel and chain guards for bicycles were cast in aluminum, and to prevent cracking, it was the practice to remove the copes before the sprues had solidified and to ease the castings from the sand so that they would be free to contract. The result was not always satisfactory, although it undoubtedly helped.

The copper-tin alloys comprised all of the brass foundry metals that have been melted and cast since the days of Tubal Cain. Those of us who can cover 25 years in retrospect, must be impressed with the fact that while we have progressed so far as quantity is concerned, the same cannot be said of the quality of the castings. Among the world's wonderful castings are the Colossus of Rhodes, the Russian and Chinese bells, and the casting the boys used to make in the saloon on Saturday afternoon. It was so large that one of the molders had to ride around the mold on horseback to light the vents and it was so big that an oil barrel had to be used as a pattern for the riser. So far as ordinary brass and bronze are concerned, it is difficult to note much progress in the last 25 years and this is largely due to the fact that the founding of these alloys, as practiced at present, has been thoroughly understood for centuries.

Weapons of War

During one period, bronze was used extensively in the manufacture of weapons of war, and as a result it received careful study; its properties and peculiarities, even the desirability of rapid cooling, were thoroughly understood. To counteract the harmful effects of slow cooling, heavy cannon were cast with water-cooled cores centrally located. To accomplish this feat without disaster, would tax the resources of most plants today.

With the possible exception of the aluminum alloys, none is so unsuited for casting in sand molds as the copper-tin series, because the heat-conducting power of damp sand is extremely low; the sand, therefore, promotes the slow cooling of the metal, which in turn causes segregation in the constituents of the alloy, resulting in a comparatively weak casting. Copper-tin alloys should be cooled as quickly as possible after the metal has filled the mold, but the surplus metal used for feeding to replace shrinkage, should cool slowly so that it may perform its office to the best advantage.

For important castings, however, a better molding medium than sand should be discovered. Many new refractory substances have been placed at the disposal of the casting industry in recent years by the development of the electric furnace and it seems that an artificial molding medium could be produced that would fulfill, better than sand, the requirements of a mold for these alloys. Such a molding material should conduct heat better than sand; it should make a stronger mold, so that cores could be set without crushing the mold and it should be more refractory than sand.

Molding and Coring a 5-Ton Gear Cutter Bed

(*Continued from Page* 365)

floor. The casting is shown in Fig. 6, just after its removal from the pit, having been rolled over on its side. Fig. 7 is a view of the casting chipped and ready for shipment.

The casting was out of the sand by 10 o'clock Monday morning, and the pit was soaked for the remainder of the day, having been cleaned out by the night gang and was ready for another mold on Tuesday morning.

The hook bolts do not bind on the rod as might be imagined, the heat of the casting causing them to expand until they are at least ⅝-inch away from the bottom of the rod extending through the lugs. The planed surfaces of the lugs make excellent bearings for the body cores. As the frame is never disturbed, it is unnecessary to make a new cinder bed or to level the pit bottom. By night of the first day the pit is ready for the cope and by the evening of the second day it is under fire.

R. J. Doty, who has been in charge of the steel foundry operated by the Isaac Johnson Co., Spuyten Duyvil, N. Y., during the past three years, has resigned to become associated with the Sivyer Steel Casting Co., Milwaukee. The plant of this company is to be considerably enlarged and a 3-ton electric furnace will be installed to provide additional melting capacity.

Welding Institute Established

The Davis-Bournonville Co, Jersey City, N. J., has established a welding institute for the purpose of giving instruction in the oxy-acetylene art. The institute was opened on Aug. 1 and the courses and their cost follow: Instruction for experienced operators, one week, $100; instruction for superintendents, foremen and students of exceptional ability, two weeks, $150; and the general course of instruction, four weeks, $200.

The institute is under the supervision of Henry Cave, technical director for the Davis-Bournonville Co. His assistants not only are engineers of considerable practical experience, but also are instructors who are familiar with the best methods of imparting information.

Pig Iron Production Declined During First Half of Year

According to statistics issued by the American Iron and Steel Institute, the pig iron production during the first half of this year totaled 19,258,235 tons as compared with 19,699,522 tons during the same period last year. This shows a slight decline which must be attributed to the fuel shortage and repairs to furnaces which had to be made on account of the hard driving of these plants for a period of nearly two years. The foundry pig iron and ferrosilicon output declined nearly 500,000 tons, the output for the first half of this year having reached a total of only 2,602,448 tons as compared with 3,086,410 tons for the first half of 1916. On the other hand, the malleable pig iron production showed an increase of nearly 50,000 tons for these respective periods, the output during the first half of this year having been 509,982 tons as compared with 460,839 tons during the same period in 1916.

T. P. Kelly & Co., Inc., New York City, manufacturers of foundry facings and supplies, are adding two new buildings to their large plant at Stockertown, Pa., to take care of their increased volume of business. Additional power and milling machinery is being installed.

Th Western Electric Co., New York, has established three new electrical supply houses, one to serve the trade in Connecticut and adjacent territory, located in New Haven, in charge of Tyler L. Holmes. A warehouse also has been established at Baltimore, in charge of S. Greenfield, and one at Charlotte, N. C., in charge of R. H. Bouligny.

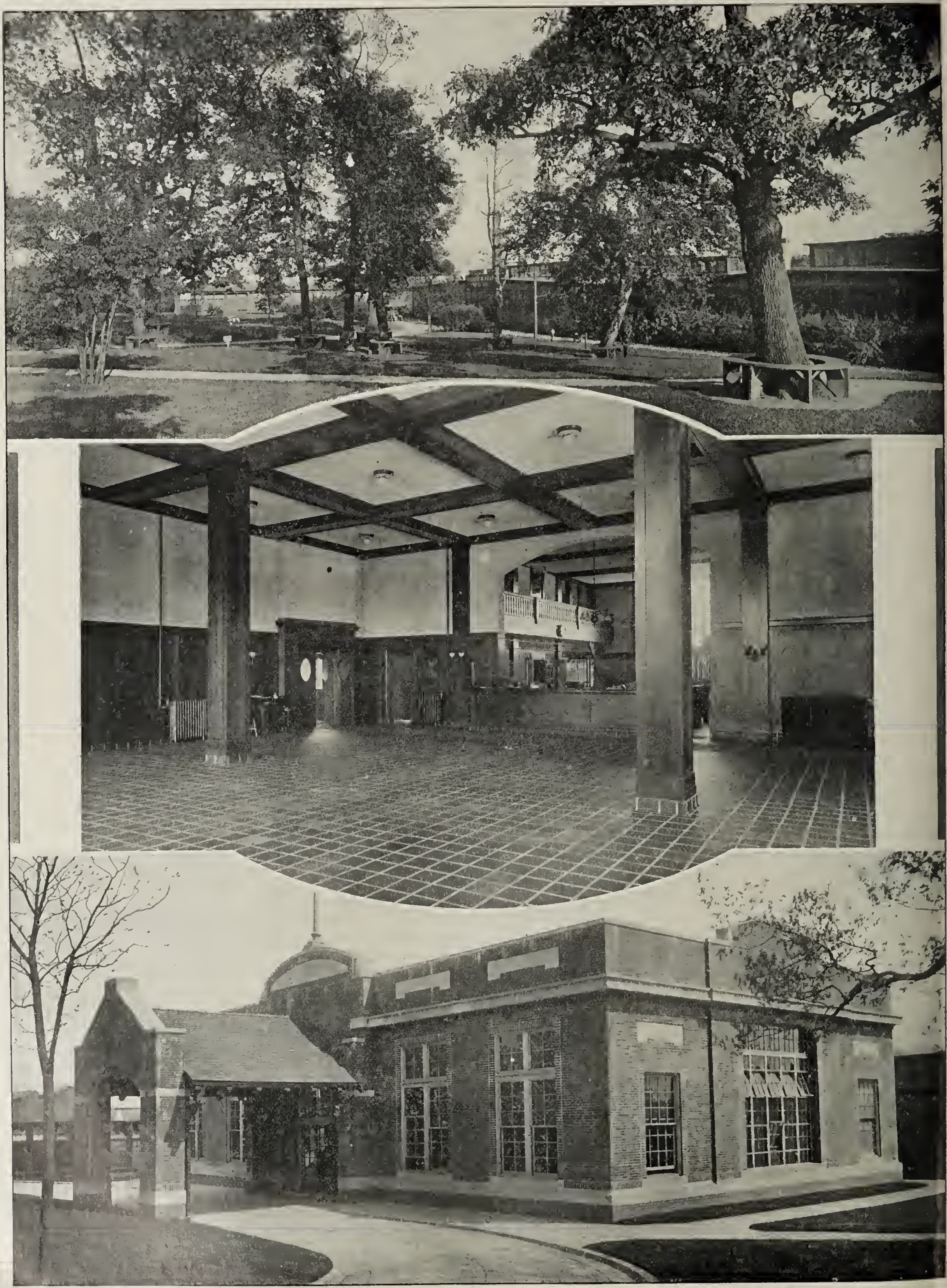


FIG. 1—BEAUTIFUL TREES AND WELL-KEPT LAWNS BORDER THE FOUNDRY BUILDINGS ON THE NORTH
FIG. 2—A NEW DEPARTURE IN DESIGN OF FOUNDRY OFFICES
FIG. 3—ENTRANCE TO WALKER & PRATT MFG. CO.'S PLANT SHOWING EXTERIOR OF SUPERINTENDENT'S OFFICE

Making Cook Stoves for Uncle Sam's New Army

How Far-Sighted Foundry Planning Enabled a New England Manufacturer to Meet an Emergency Order for Cantonment Equipment

By E L Shaner

IN EFFECT, the great war is the inventory taker, organization inspector, efficiency checker and ultimate appraiser of America's industries. For many years manufacturing has progressed or declined, according to the demands of business. The amount of he quarterly dividend in many cases has been the criterion of ability to conduct business effectively. In the period of normal conditions, no opportunity was presented for testing he ability of manufacturers to meet an unforeseen emergency.

War has changed this status of hings. Now that the United States has entered the conflict, practically very branch of industry is confronting an xacting test of preparedness. In this baptism of fire, the manufacturers are finding that wise lanning when their lants were built, propr management during he growth and development of the business, nd farsightedness in erfecting an organization are assets of inesmable value in successfully satisfying war's nusual demands. The dvantages of constanty preparing for the uture are well illusrated by the experience f the Walker & Pratt Mfg. Co., Boston, now ngaged in making ooking ranges for ne of the large cantonments under construction for the United States army. hat the company was able to undertake he manufacture of this equipment on hort notice and without seriously interering with the production of the usual ne of stoves and furnaces, is largely ue to a policy of foundry planning dopted nearly 20 years ago when the riginal buildings of the present plant t Watertown, Mass., were erected. ig. 5, reproduced from page 194 of he July, 1899, issue of THE FOUNDRY, a plan of the buildings erected in hat year. Fig. 6, taken from page 195 of the same issue of THE FOUNDRY, shows the "probable plan when capacity is doubled". The extreme accuracy with which the men who planned for future extensions, predicted the growth of the business may be judged by comparing the proposed plant, Fig. 6, with Fig. 7, a plan drawing of the buildings as they actually exist today. The policy of expansion adopted nearly 20 years ago was so well suited to the conditions that later developed that the proposed plans were followed in almost every minute detail. The fact that the dimensions of the present warehouse, foundry, pattern storage, and core room exceed those of the proposed plan for a plant of double the original capacity, is further evidence of the care with which the buildings were first laid out.

The processes involved in casting, fitting and assembling stoves in the plant of the Walker & Pratt Mfg. Co. are the result of experience covering a great many years. Unlike many stove manufacturers, this company has developed its organization to insure sufficient accuracy in making certain castings so that the parts are interchangeable. This feature alone is responsible for the elasticity in shop schedules which has enabled the company to execute large orders with minimum delay and confusion. Stoves whose parts are interchangeable may be shipped in a partly assembled condition, thereby conserving shipping space and minimizing the danger of breakage.

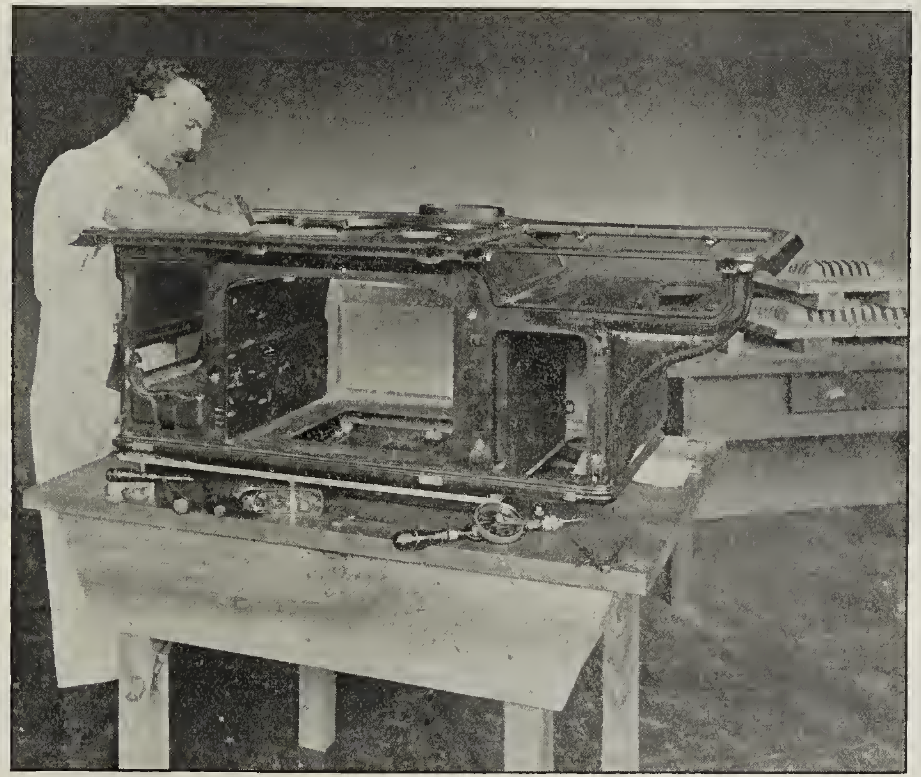


FIG. 4—A MODEL OF THE STOVE IS MADE OF WOOD PATTERNS

The first step in turning out stoves of the kind built by the Walker & Pratt Mfg. Co., for the army cantonment, consists in making the master patterns of the stove plates from the designer's drawings. The separate patterns are then assembled, forming a complete model of the stove, as illustrated in Fig. 4. In stovemaking, the patternmaker not only must be careful to shape the patterns to meet the conditions imposed by current molding practice, but also must be careful that the patterns admit of easy assembling and dismantling to facilitate the replacement of broken parts. The work in the pattern shop is closely allied to the methods of molding employed in the foundry. This close relationship was emphasized when it became evident that castings must be produced with unusual rapidity to supply the army cook stoves as fast as the government called for them. In the effort to speed-up production it was doscovered that by simply altering a number of patterns, work that had been done by hand in the foundry, could be molded on machines. In one instance, an oven door that previously had been molded by hand, was redesigned to be cast in two parts, each of which was easily molded on a hand-operated squeezer machine. In another case, a small lug which had prevented a certain casting from being machine-molded was cast separately, thus permitting the piece to be made on a machine. The independently-cast lug was then

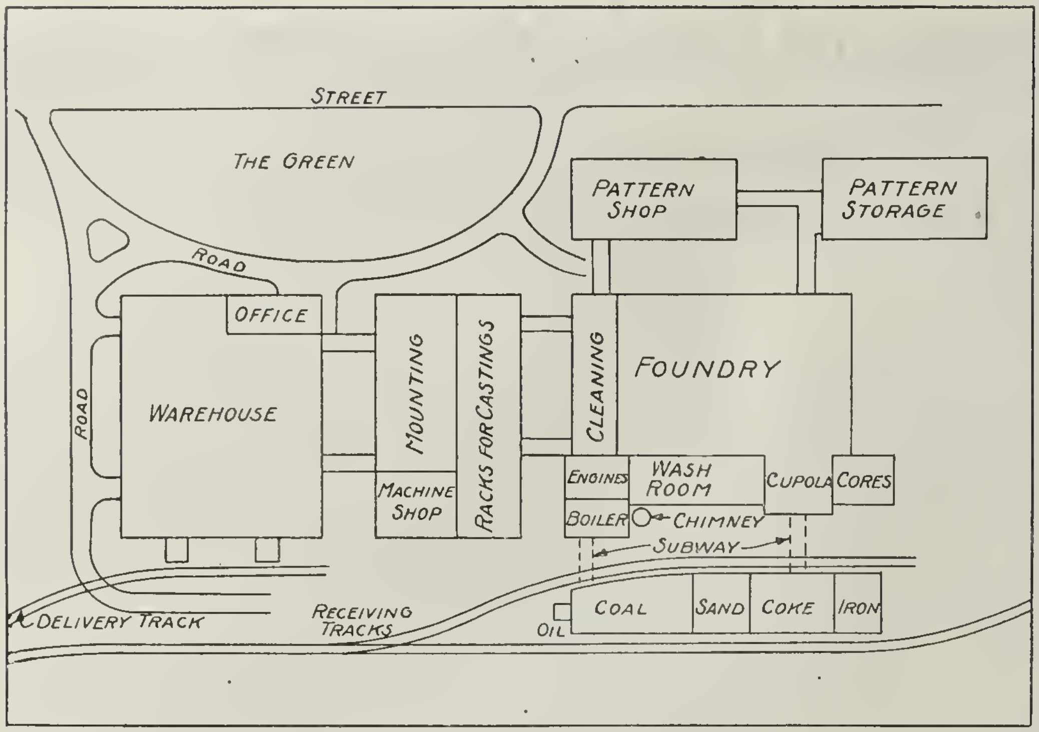


FIG. 5—GENERAL PLAN OF BUILDINGS ERECTED IN 1899

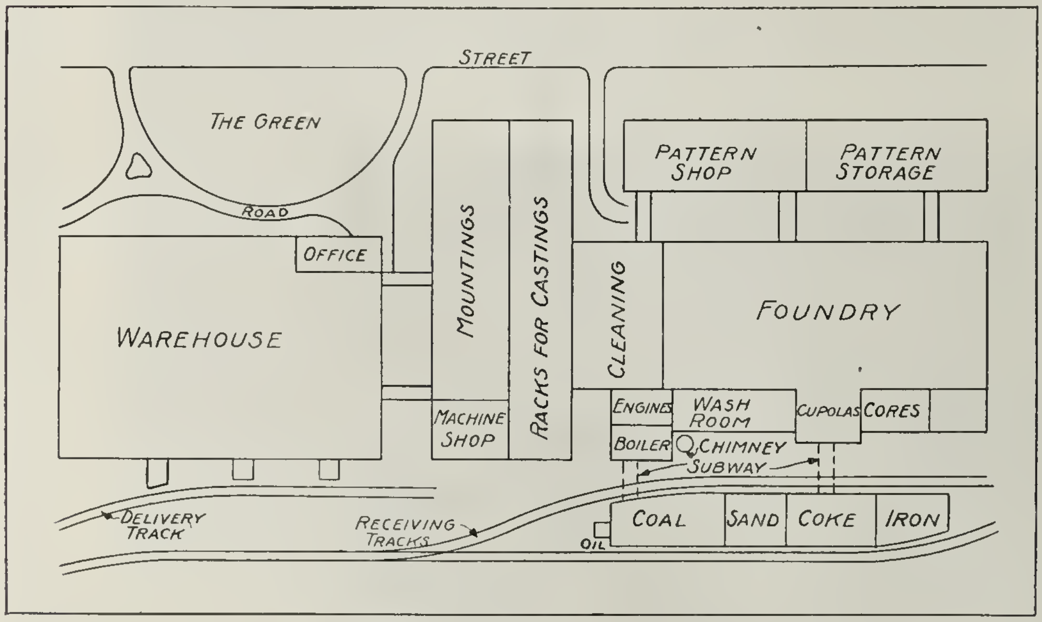


FIG. 6—PLAN OF EXPANSION PROPOSED IN 1899

bolted to the other piece, the resultant two-part casting replacing the single piece at a considerably lower production cost. The adoption of the molding machines for a large part of the emergency work in connection with the government order also was responsible for a great saving in flasks.

The wood patterns are made in the shop shown in Fig. 19. An adjacent room, equipped with similar woodworking machinery serves as a flask shop. Metal patterns and pattern plates are made in what is known as the "iron pattern shop" in the building containing other patternmaking and storage rooms. Fig. 20 is a view through the center aisle of the pattern storage building. Patterns and plates are arranged on numbered racks grouped in sections designated as *A*, *B*, etc. The pattern equipment for a certain stove is grouped on a shelf of one of the racks, and given the section letter and rack number, an attendant can readily find any pattern desired.

Preparing Sand for Stove Molding

Granting that the stove patterns used by the molders always are in first-class condition, smooth, fine-grained castings cannot be produced unless the molding sand is of the required quality. The Walker & Pratt Mfg. Co. uses a high grade of fine Albany molding sand and submits it to a drying and milling treatment that has proved highly satisfactory. The sand house is situated south of the main foundry buildings. The sand is unloaded from railroad cars on either side of the building into large bins, one of which is shown at the left in Fig. 9. The sand is placed on the four tables shown in Fig. 8, and is subjected to the heat radiating from steam coils. When it is thoroughly dried, the sand is scraped off into the specially-made

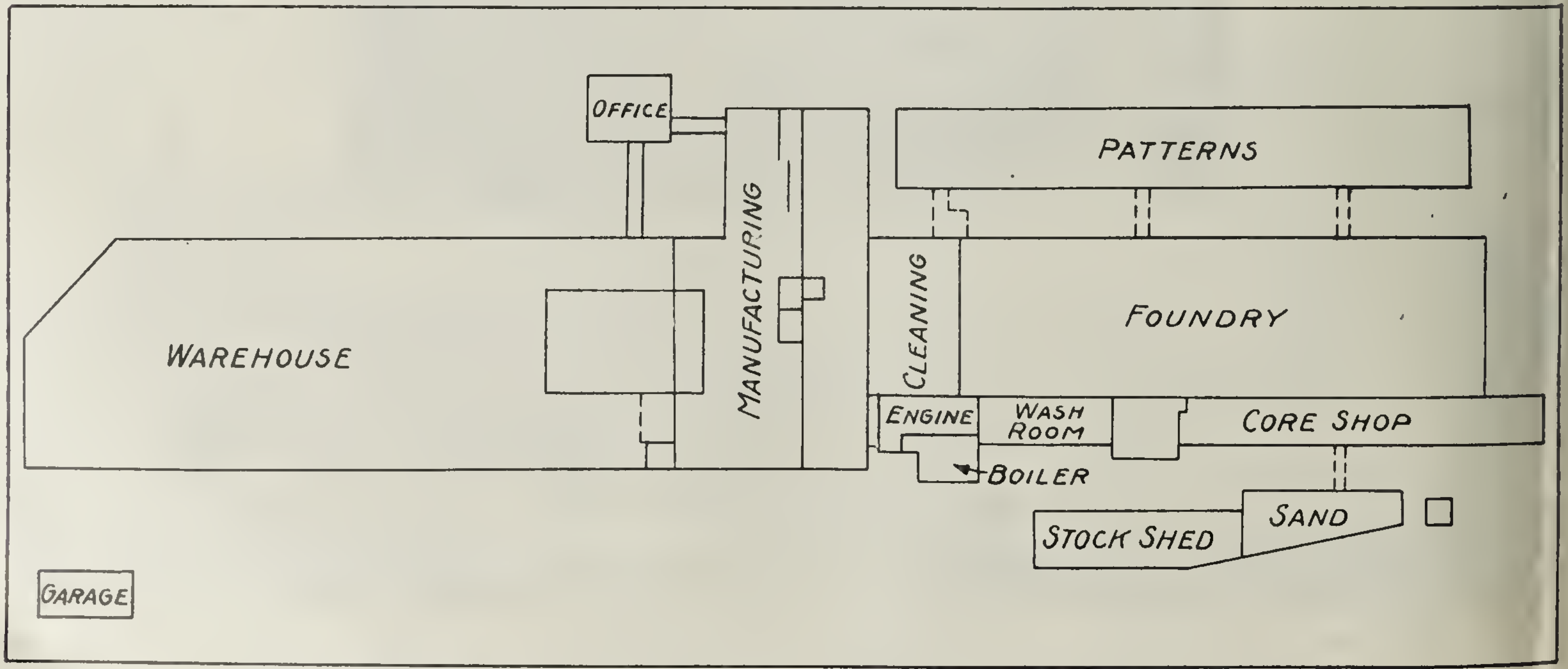


FIG. 7—PLAN OF THE STOVE PLANT AS IT EXISTS TODAY—A COMPARISON OF THIS DRAWING WITH FIG. 6 SHOWS HOW ACCURATELY THE GROWTH OF THE BUSINESS WAS PREDICTED IN 1899

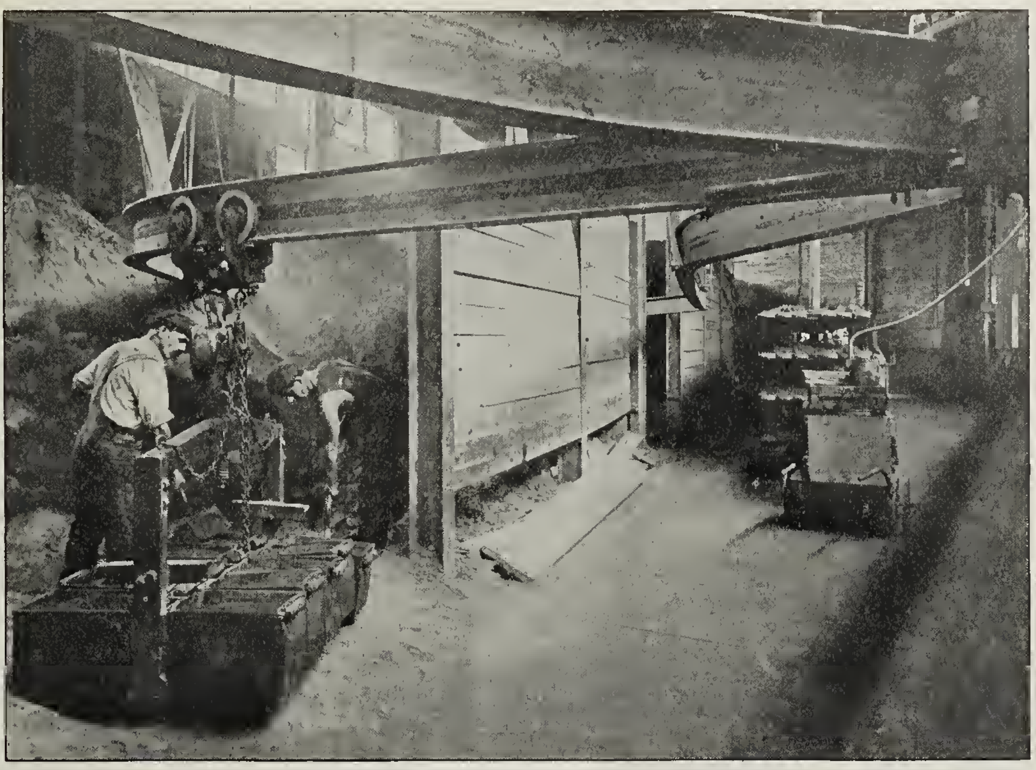


FIG. 9—STORAGE BIN IN SAND HOUSE AND CARRIER FOR CONVEYING SAND

heelbarrow shown in the illustration. he sand then is dumped through a rating in the floor onto a bucket coneyor which carries it to a crusher verhead. After the sand has been horoughly milled by the crushing rolls, t passes through a 30-mesh sieve, and nto a bin terminating in two hoppers, hown in Fig. 10. Each hopper holds ust enough sand to fill the five metal oxes on each side of the carrier shown n the illustration. The boxes are filled y first pulling out slides, *A A*, allowng the lower part of each hopper to ll up, closing *A A*, and pulling out lides *B B*. The carrier, supported by 1-ton chain hoist, running on a 10-nch I-beam, is pushed through a subway o a point under the core room in the nain foundry building, where the I-beam olley track matches a section of simar track mounted on an elevator. The and carrier is lifted to the level of the ore room and foundry, where the -beam track matches a section of he monorail system which serves the nain foundry building. The sand carier is then pushed to any desired olding floor, where the attendant istributes the boxes of sand, each ox containing 100 pounds which is a onvenient amount to handle.

Insuring Smooth Surfaces

In molding stove plate, it is exremely important that the surfaces xposed to view after the stove is ssembled are made as smooth in the olding operation as possible. To ake sure that only the purest metal ollects at the outer surface of a asting, the side on which the smooth nish is desired faces the bottom of he mold. A good surface is further sured by facing the mold with a owder of fine charcoal and black ad, and printing-back, by placing he pattern for a moment on the cing and returning it. The

molding floors of the foundry are in two adjoining bays, each of which is 60 feet wide and 420 feet long. An area of 100 x 120 feet at the east end of the building is devoted to machine molding. Light hand molding is done in the west section of the north bay, and heavy furnace work is molded in the west part of the south bay. As shown in Fig. 7, the engine, wash and core rooms adjoin the main foundry buildings on the south. Fig. 12 shows a section of the hand molding department and Fig. 11 illustrates one bay of the extension devoted to machine molding. It will be noted from these views that the molding floors are of concrete and that the runways under the monorail system are depressed about ½ inch below the level of the main floor. Typical machine-molded

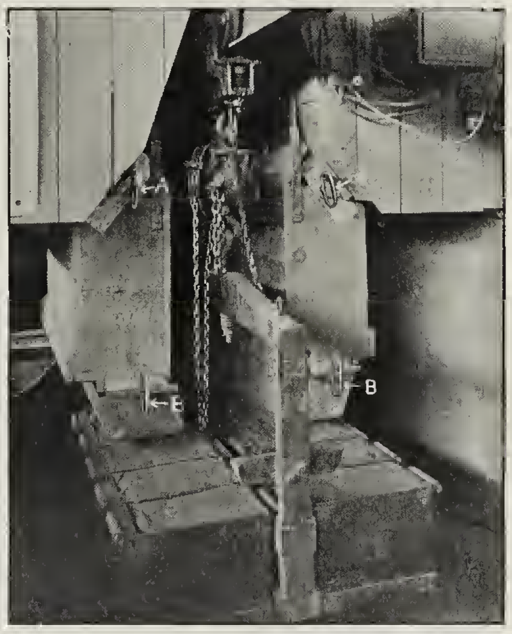


FIG. 10—HOPPER FOR FILLING SAND DISTRIBUTING BOXES

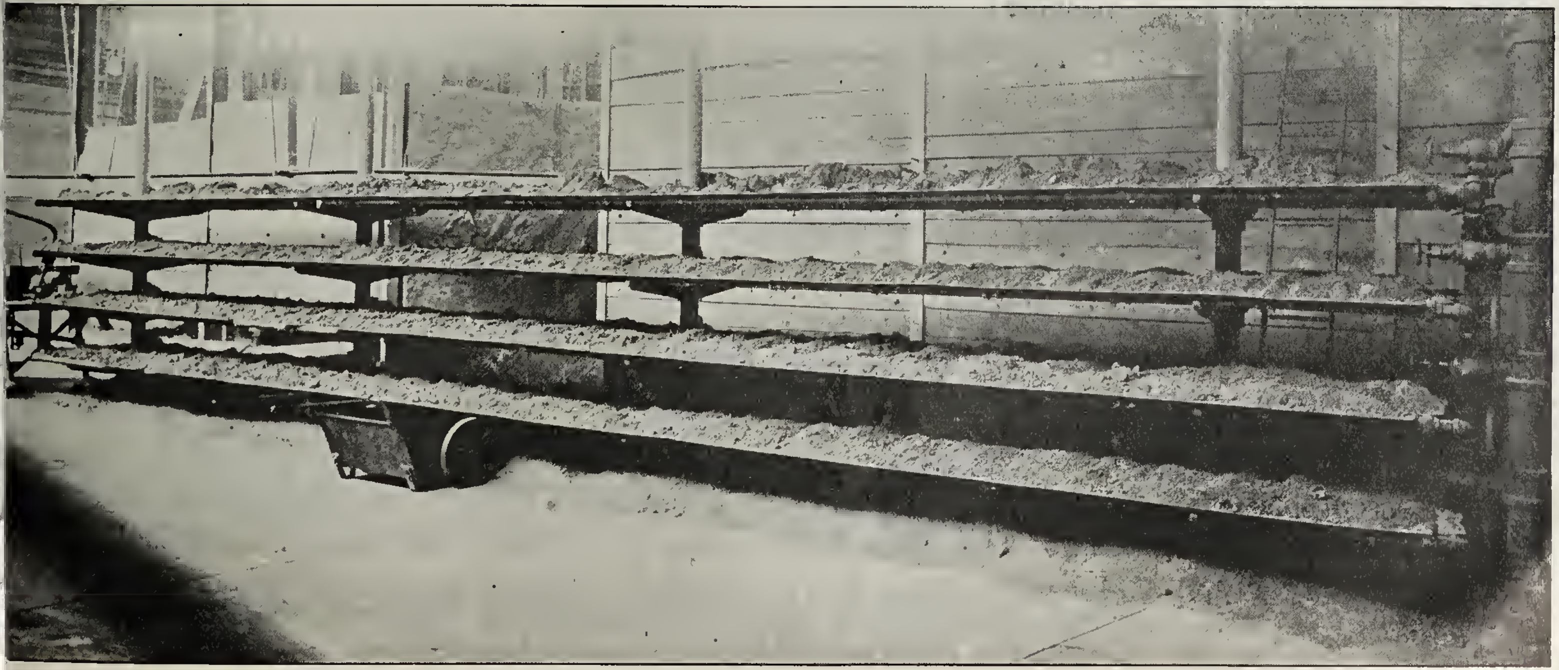
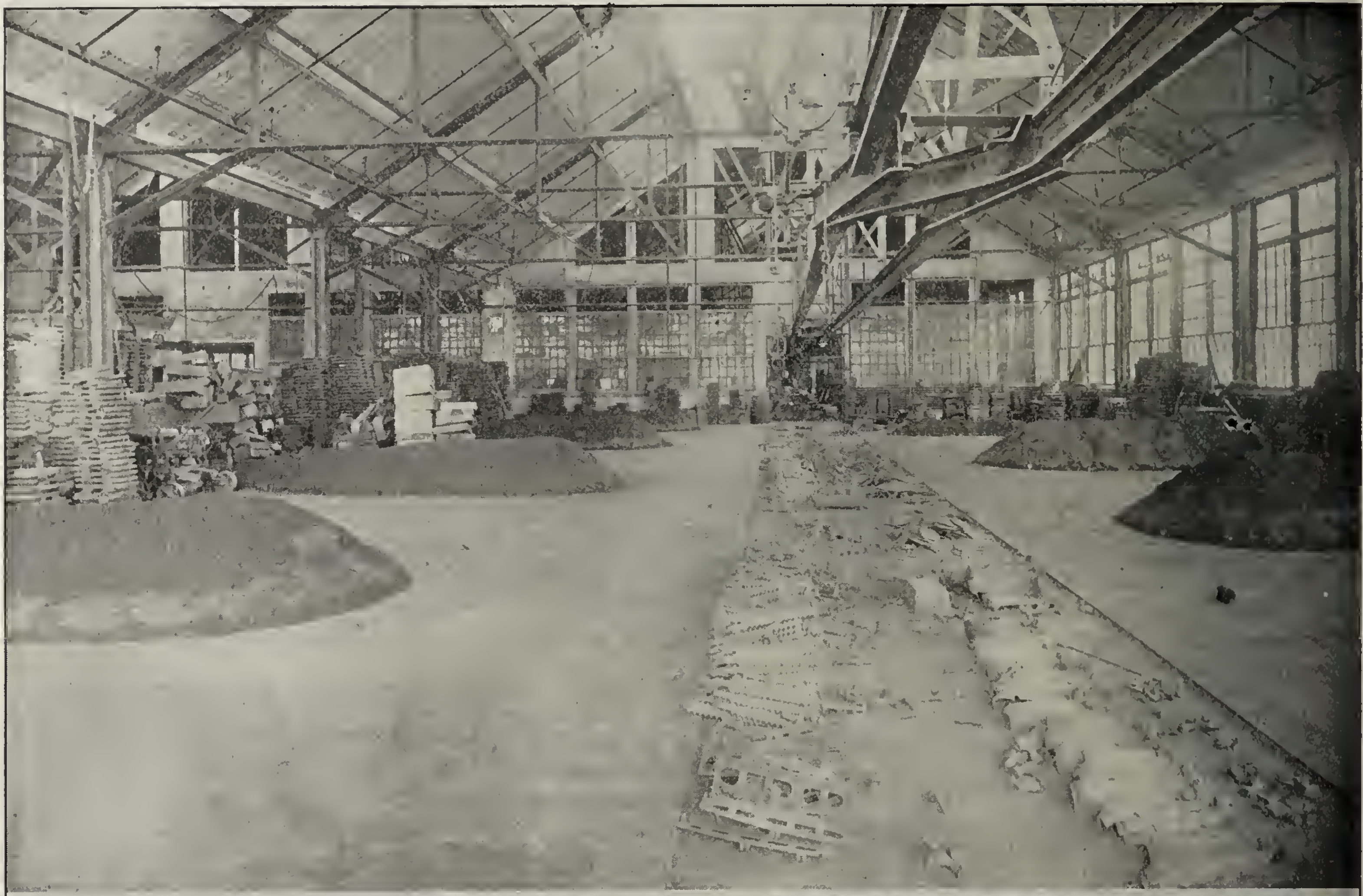


FIG. 8—ALBANY MOLDING SAND IS DRIED ON TABLES HEATED BY STEAM COILS



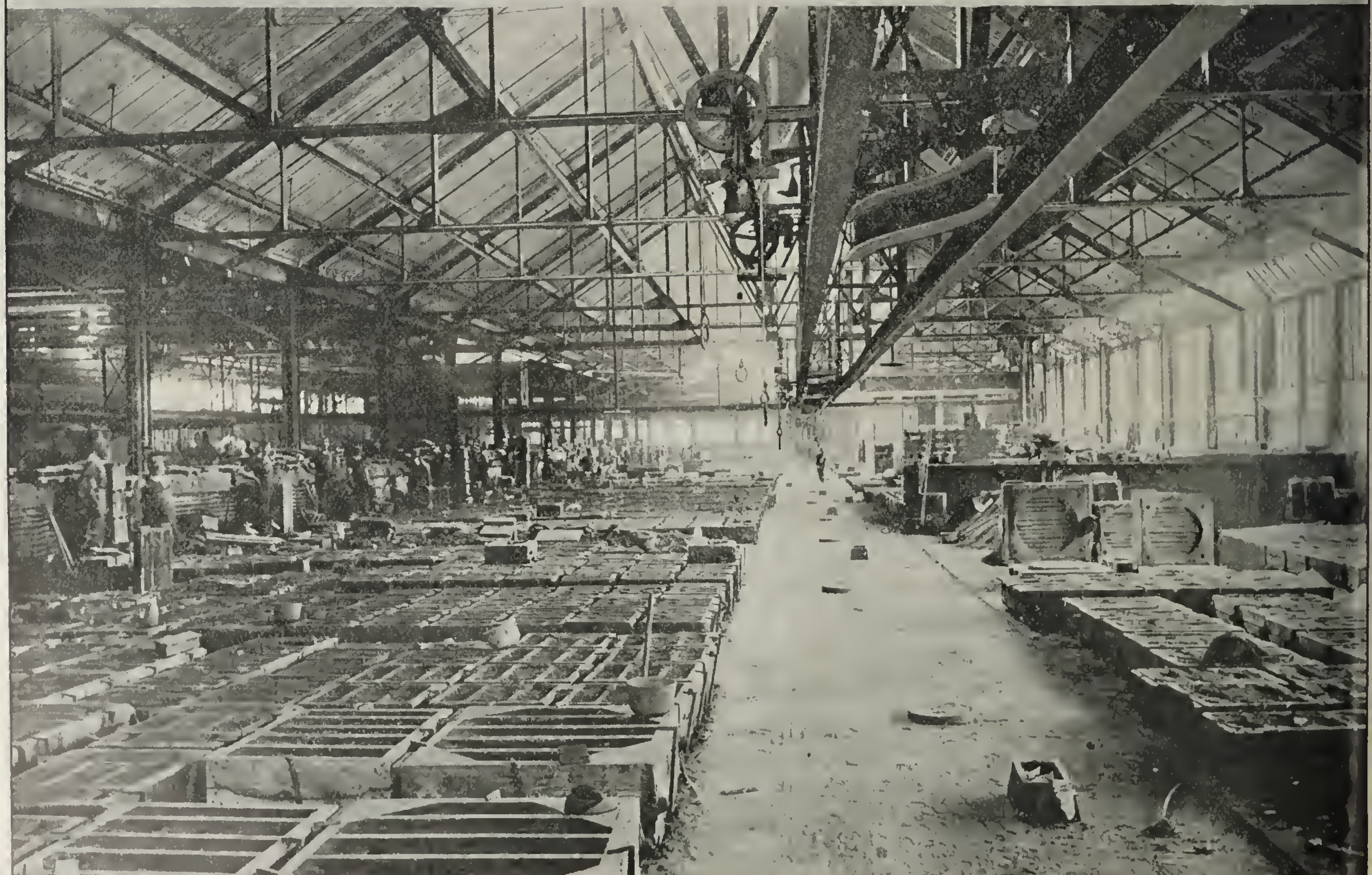
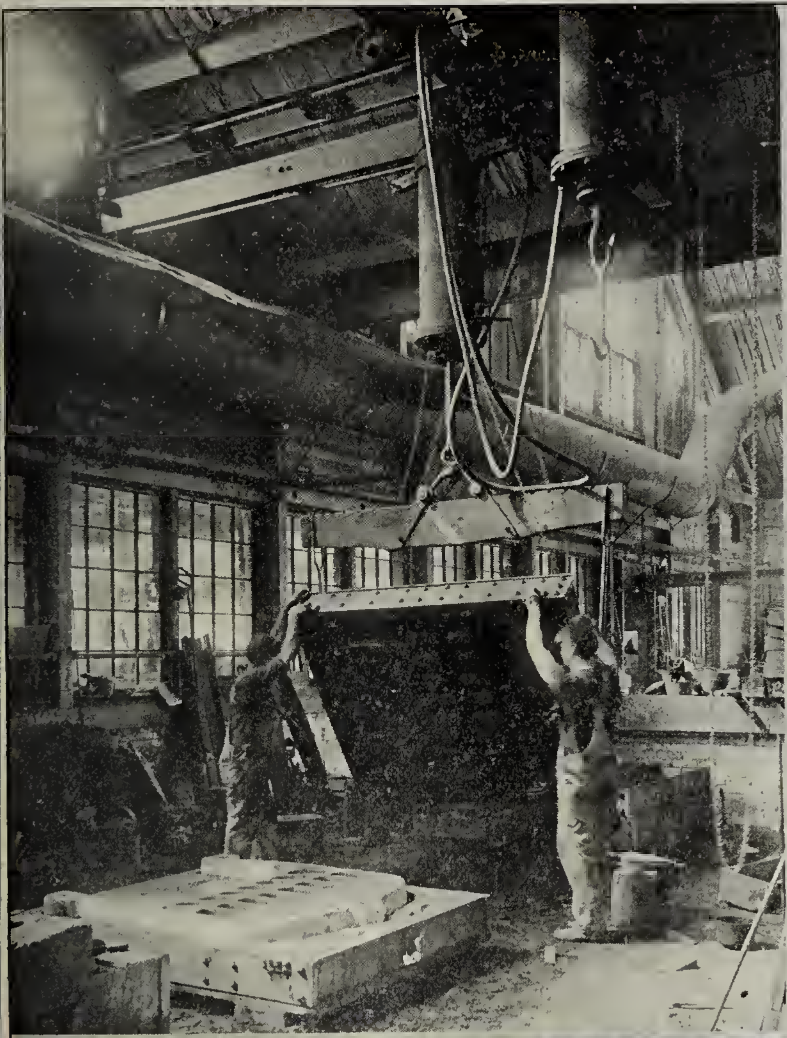
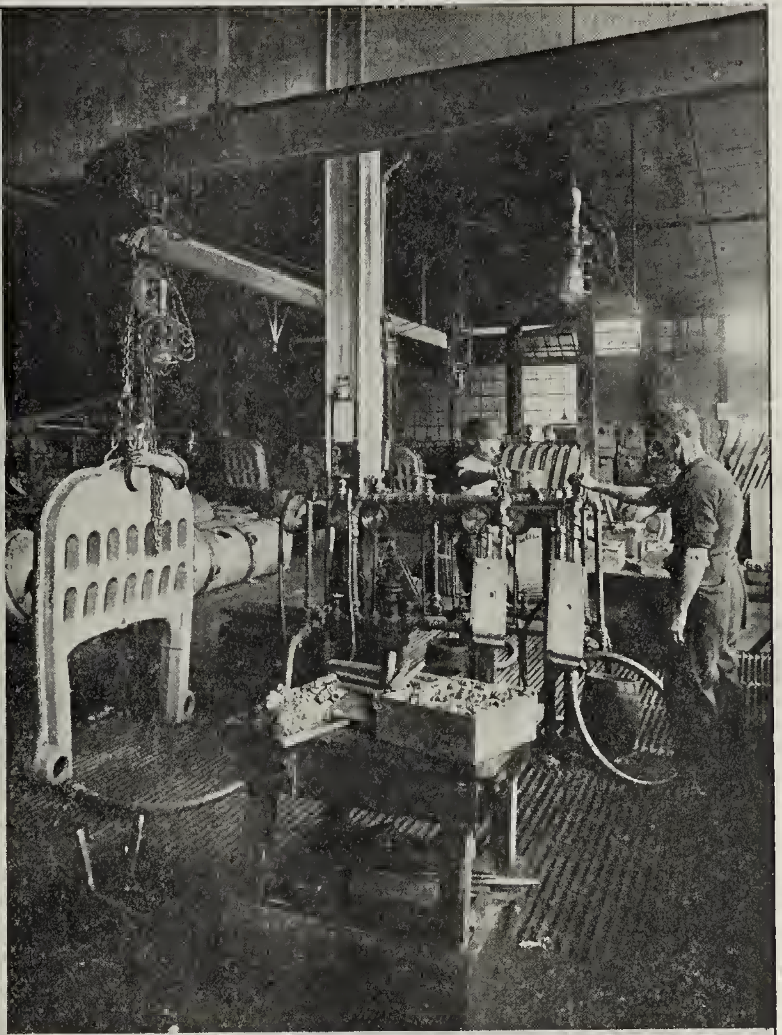
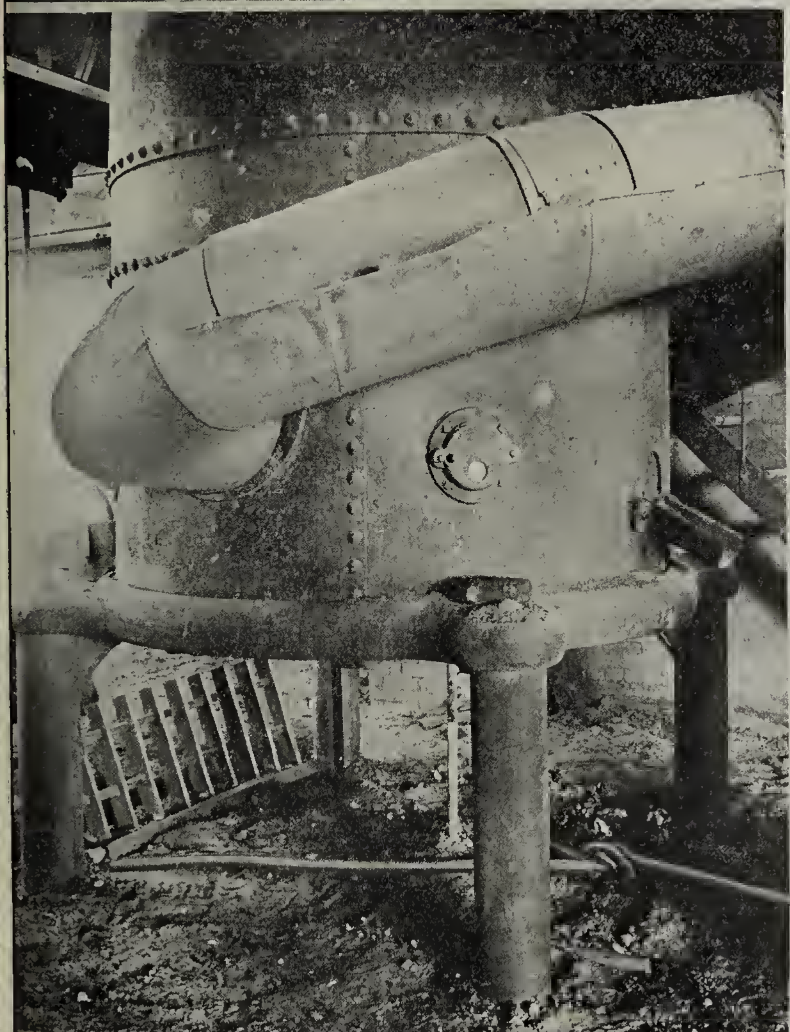


FIG. 11—MACHINE MOLDING ROOM—NOTE CONCRETE FLOOR WITH DEPRESSED RUNWAY. THE MONORAIL SYSTEM IS CLEARLY SHOWN. FIG. 12—SOUTH BAY OF THE FOUNDRY PROPER WHERE THE HEAVIER STOVE CASTINGS AND THE BOILER SECTIONS ARE MOLDED







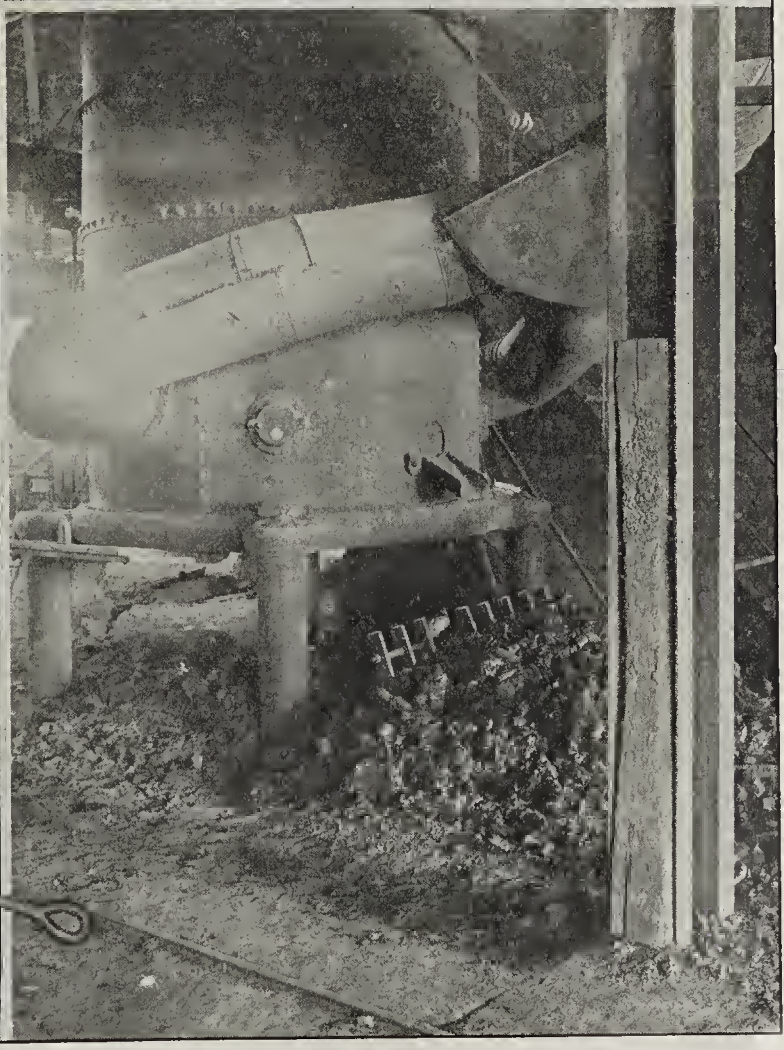


FIG. 13—CLOSING MOLD FOR LARGE BOILER SECTION. FIG. 14—ERECTING BOILER SECTION FOR HYDRAULIC TEST
FIGS. 15 AND 16—DRAG USED IN CONJUNCTION WITH CHARGING ELEVATOR TO REMOVE CINDER WHEN BOTTOM OF CUPOLA IS DROPPED

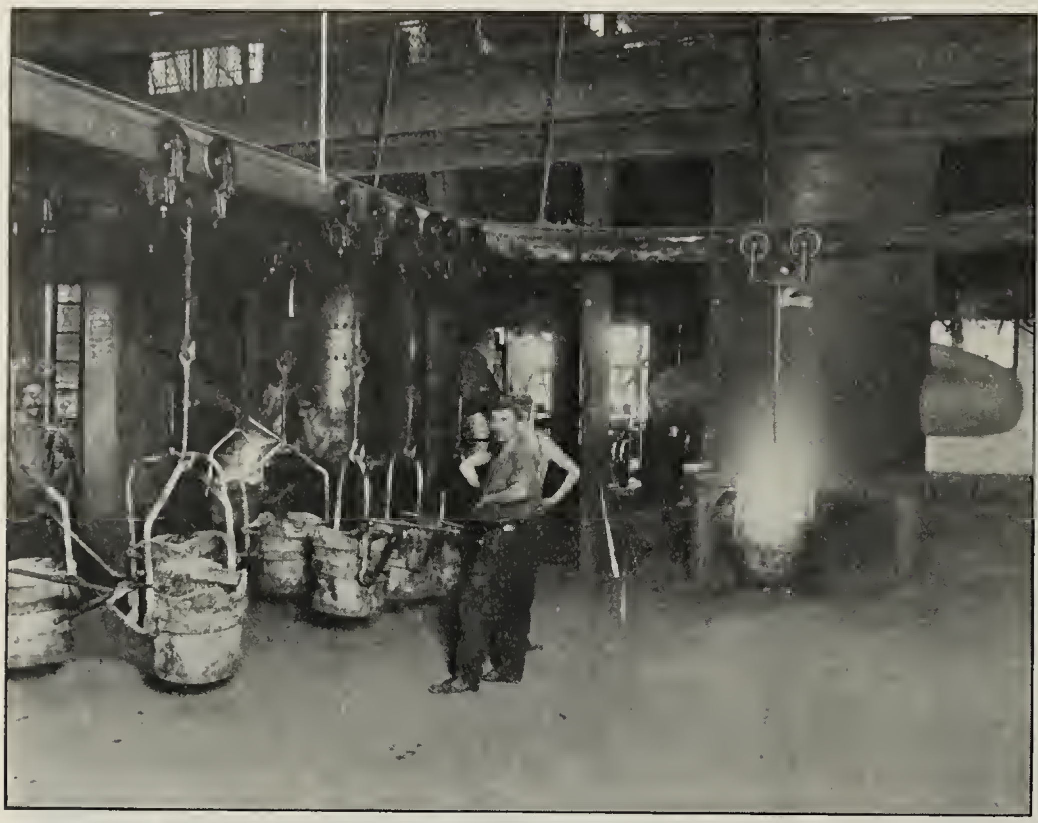


FIG. 17—METHOD OF CARRYING MOLTEN IRON FROM CUPOLAS TO THE MOLDING FLOORS, A DEPARTURE FROM THE USUAL PRACTICE

stove castings that have been shaken-out from the molds are shown in the runway in Fig. 11.

Molding Boiler Sections

The largest castings made in the Walker & Pratt foundry are sections for heating boilers. Fig. 13 shows the drag of a mold for a boiler section with the core in place. The cope is being lifted by the aid of a 14-inch air hoist. The cores for molds of this kind are made in halves in large metal core boxes, and are later pasted together. The 14 openings through the casting are formed by projections in the cope and drag instead of by the use of separate cores. The mold is gated at either end, to permit simultaneous pouring from two ladles. Fig. 14 shows a boiler section being set up for test. Each section is subjected to a hydraulic pressure of 100 pounds per square inch.

The melting equipment of the foundry consists of three cupolas, one of which is held in reserve. The charges of pig iron, coke, limestone and scrap stove plate are made up in small cars in a stock room adjoining the sand house. The cars run on a narrow gage track through a subway to an hydraulic elevator which lifts them to the charging floor, shown in Fig. 18.

Novel Use of Elevator

Figs. 15 and 16 show a unique method of dropping the cupola bottom after the iron has been tapped. The drag, in the position shown in Fig. 15, is attached to the hydraulic charging floor elevator by a wire cable passing through blocks placed at convenient points in the elevator well. When the elevator rises, the drag grips the bottom supports and sweeps the falling cinder to the back of the cupola, as indicated in Fig. 16.

The distribution of iron to the molding floors in the Walker & Pratt foundry is accomplished by bull ladles supported from trolleys running on a 10-inch I-beam track. It is customary in many stove foundries to tap the metal into the hand ladles from the cupola, and even in the most recently built stove plants, molders are required to go to the cupola for their iron. The monorail system enables the molders to remain at their respective molding floors, and lessens the confusion and danger of accident in handling molten iron. The arrangement of the ladles and cupola monorail system is illustrated in Fig. 17.

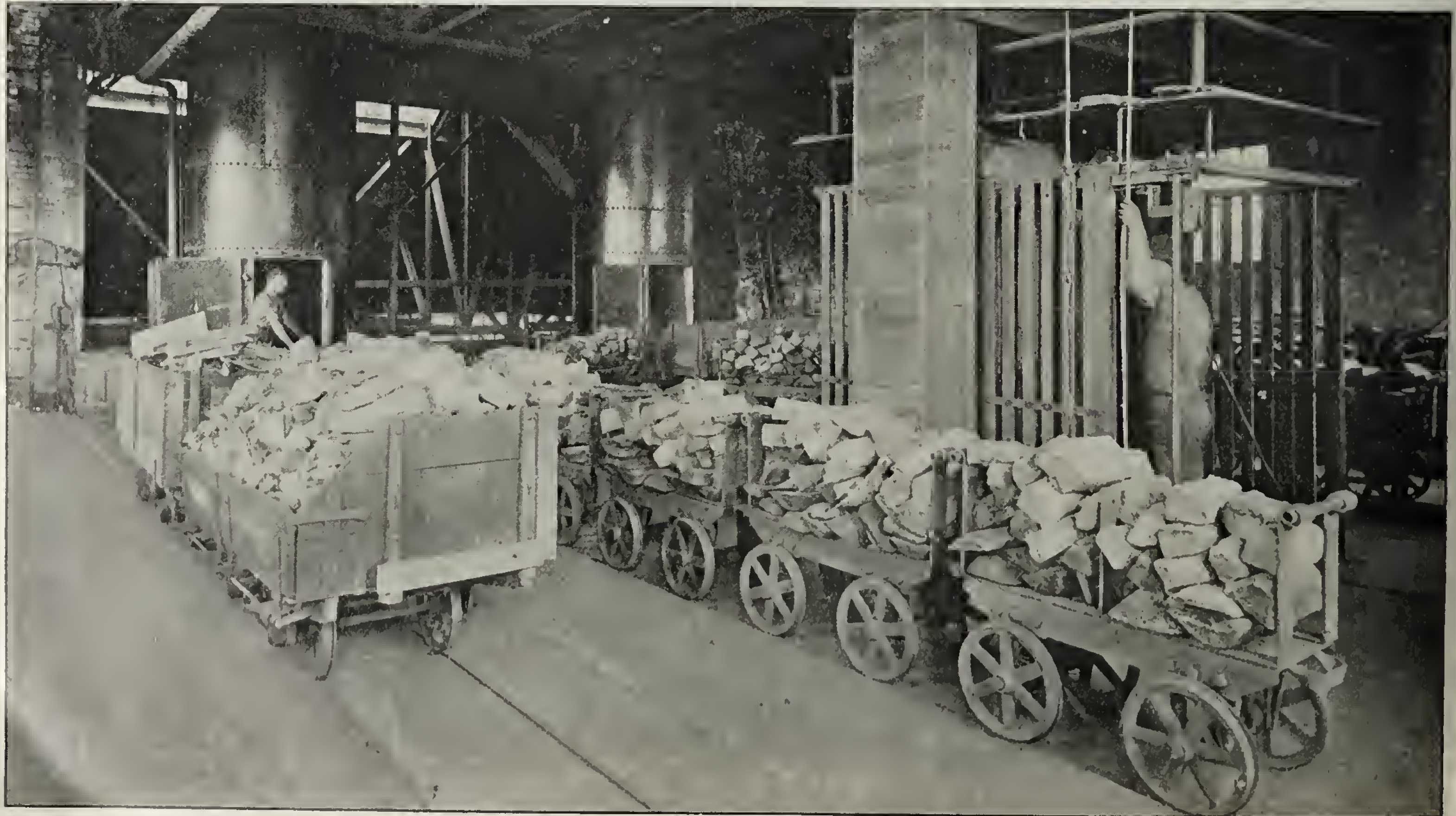


FIG. 18—THE CHARGING PLATFORM IS OF AMPLE PROPORTIONS—THE CHARGES ARE WEIGHED BEFORE THEY REACH THE CHARGING LEVEL

In cleaning the stove castings, ordinary imperfections are removed by grinding on double-stand machines, while irregularities on concave surfaces are ground on vertical grinders. The tumbling barrel equipment consists of about 30 cylindrical and rectangular units. Although each machine is equipped with exhaust pipes for carrying away the sand and dust, additional precaution against dust-laden air in the cleaning room is taken by placing heavy canvas covers over the tumblers. One of these covers, made of three strips of canvas tacked to wooden cleats, is shown in Fig. 22.

Cleaned Castings are Stored

The cleaned castings are weighed, inspected for defects, sorted, and then stored in racks in a casting storage room. The storing of cleaned castings, although requiring considerable floor area, has an important bearing upon the scheduling of work in the foundry. If it were not for the facilities for storing large numbers of stove parts, it would be necessary to carefully co-ordinate the work on various pieces, so that each of the many parts for a given stove would reach the assembling room at approximately the same time. The storage room, however, enables the molding department to plan its work to suit the available molding equipment, the wider latitude of management afforded in this respect tending toward greater economy in production.

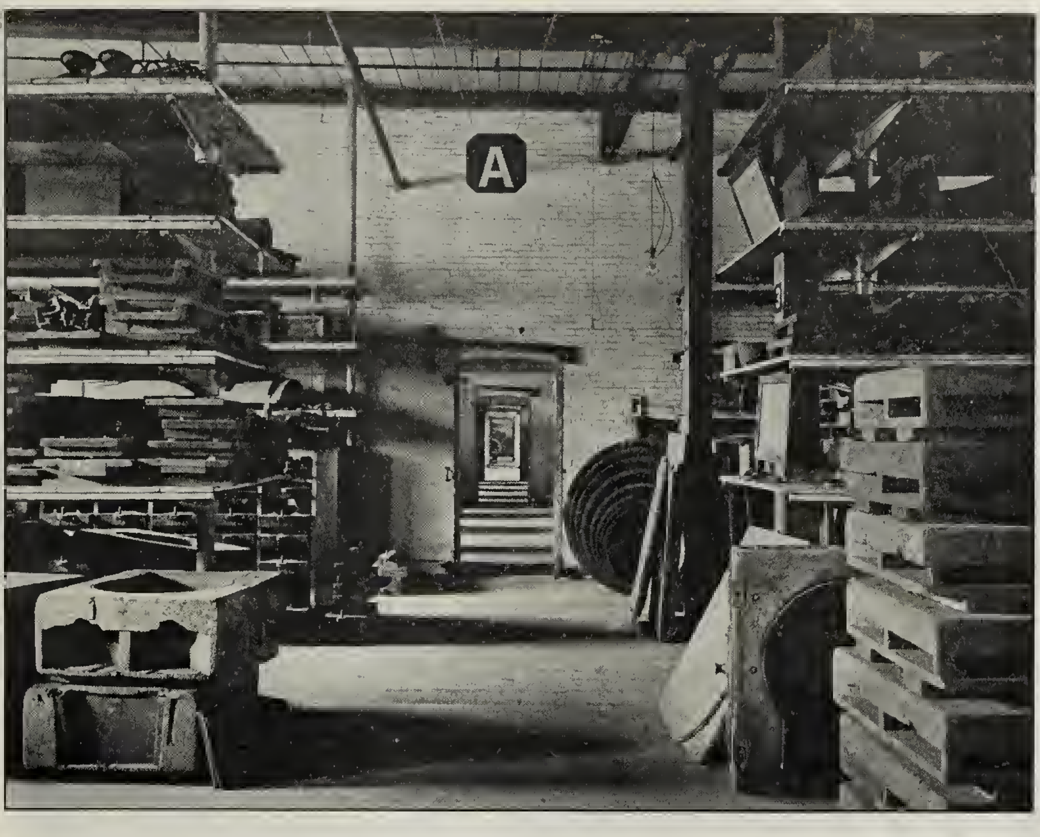


FIG. 20—A VIEW THROUGH THE CENTER AISLE OF THE PATTERN STORAGE BUILDING

The assembly of stoves involves not only the mere fastening together of the various pieces, but also the drilling and fitting of the parts which are held by bolts or screws. As previously stated, the policy of making many of the stove parts interchangeable reduces the work of fitting to a minimum. As a general rule, the body of the stove is assembled, while the legs, extensions, and other accessories are shipped knocked-down. A mounter first assembles a skeleton stove, starting with the base. In the case of the ranges for the army cantonment, the base is bolted together on a flat surface board, and the frame quickly assembled. While two mounters are engaged in this work, a fitter obtains the required doors, burners, lids, etc., from the casting room and fits them to the partially mounted stoves. Each fitter is able to provide fitted parts for the stoves which two mounters assemble. The slight alterations required to

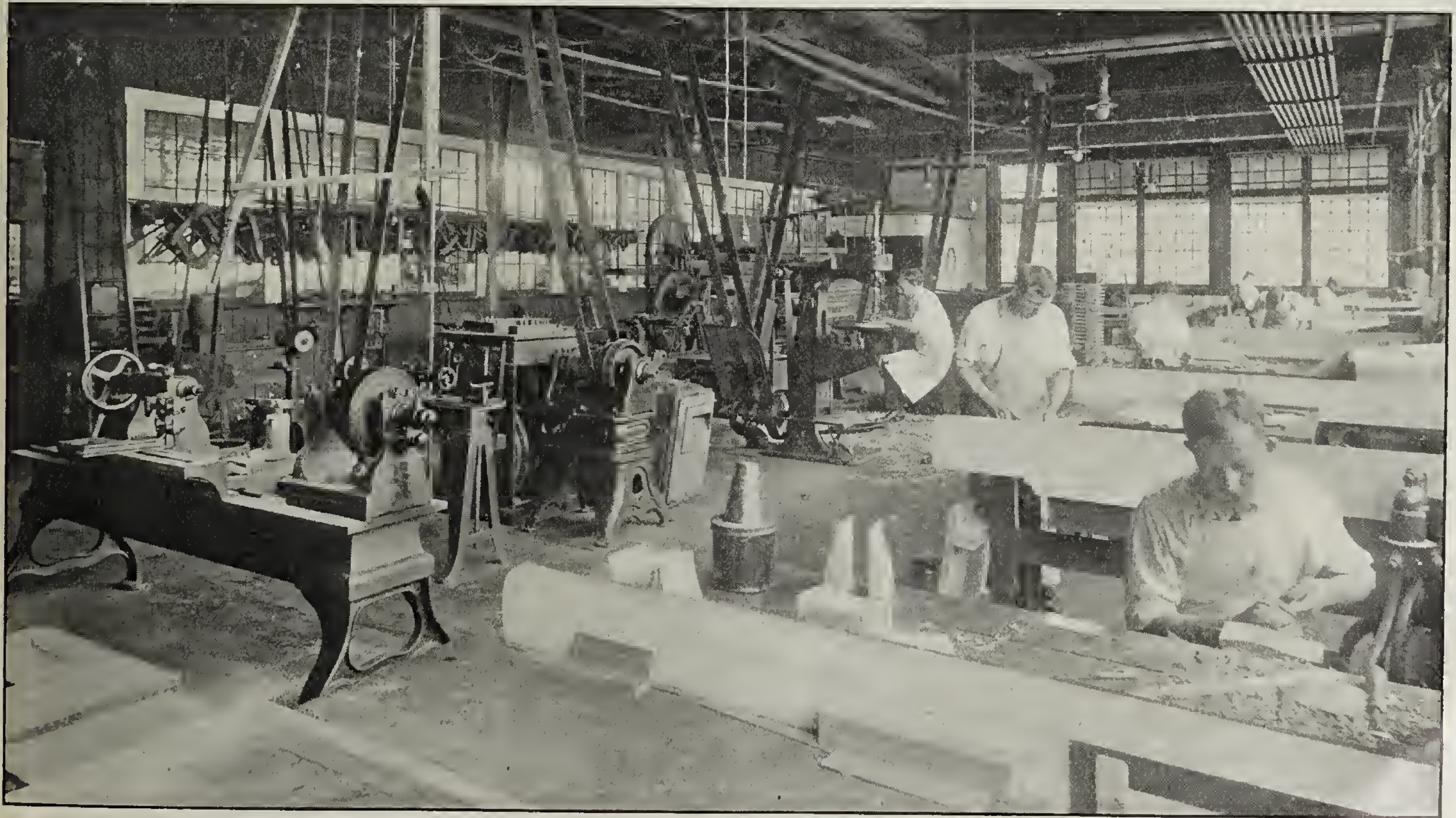


FIG. 19—A VIEW OF THE PATTERN SHOP WHERE THE WOOD PATTERNS ARE MADE—SEPARATE SHOPS ARE PROVIDED FOR METAL PATTERNS AND WOOD FLASKS

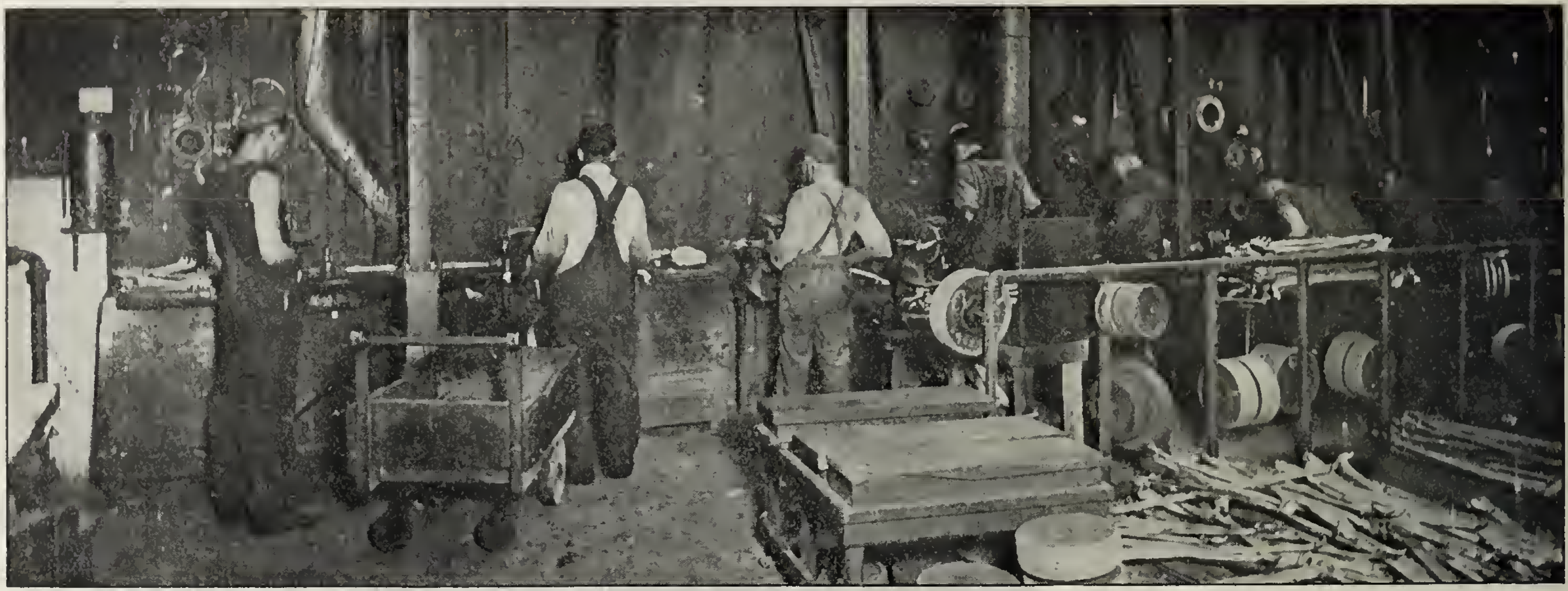


FIG. 21—THE BUFFING AND POLISHING DEPARTMENT WHERE NICKEL-PLATED PARTS ARE HANDLED

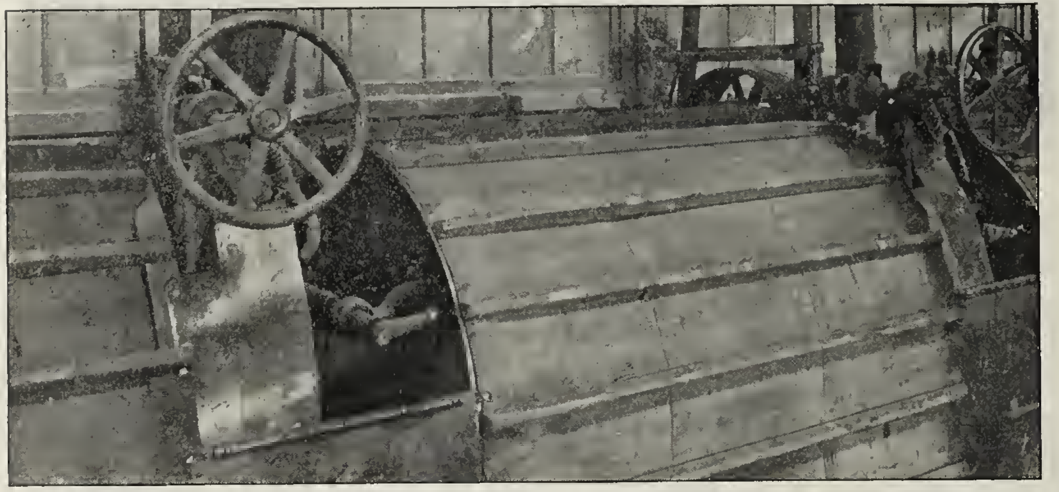
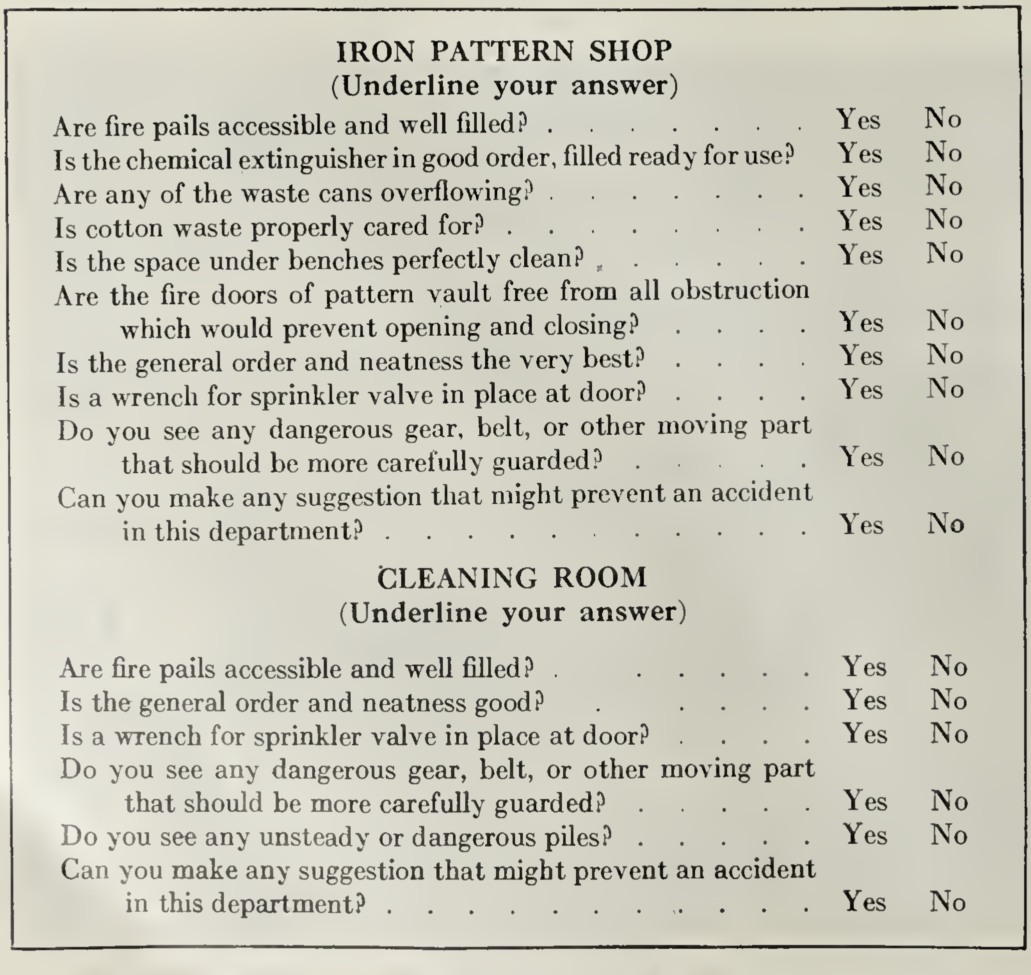


FIG. 22—A CANVAS COVERING OVER THE TUMBLING BARREL ALLEVIATES THE DUST NUISANCE



IRON PATTERN SHOP
(Underline your answer)

Are fire pails accessible and well filled?	Yes	No
Is the chemical extinguisher in good order, filled ready for use?	Yes	No
Are any of the waste cans overflowing?	Yes	No
Is cotton waste properly cared for?	Yes	No
Is the space under benches perfectly clean?	Yes	No
Are the fire doors of pattern vault free from all obstruction which would prevent opening and closing?	Yes	No
Is the general order and neatness the very best?	Yes	No
Is a wrench for sprinkler valve in place at door?	Yes	No
Do you see any dangerous gear, belt, or other moving part that should be more carefully guarded?	Yes	No
Can you make any suggestion that might prevent an accident in this department?	Yes	No

CLEANING ROOM
(Underline your answer)

Are fire pails accessible and well filled?	Yes	No
Is the general order and neatness good?	Yes	No
Is a wrench for sprinkler valve in place at door?	Yes	No
Do you see any dangerous gear, belt, or other moving part that should be more carefully guarded?	Yes	No
Do you see any unsteady or dangerous piles?	Yes	No
Can you make any suggestion that might prevent an accident in this department?	Yes	No

FIG. 23—FACSIMILE OF PAGE OF FIRE EQUIPMENT INSPECTION BOOK

make certain castings fit in place are made on grinding wheels. There are approximately 400 pieces is an ordinary cooking range.

The assembled stoves are inspected, blacked and polished, after which the nickeled and enameled parts are mounted. In some cases the blacking is applied by a spray system in an enclosed room specially-built for this purpose. Fig. 24 is a view of the nickel-plating vats in the plating department and Fig. 21 shows the battery of grinding and buffing wheels where plated parts are prepared for the bath and polished after plating. No. 150 carborundum is used in this department, experience having proved that this material is of the proper degree of fineness to produce a desirable finish, and yet thorough enough as an abrasive to dress up the surface without scratching.

Handling Stoves in Warehouses

The stoves are carried to the warehouses on an electric storage battery truck, as shown in Fig. 25. As the floors of the storage department have almost an unlimited capacity, stoves may be piled to the ceiling. The handling of the stoves is facilitated by simply constructed traveling cranes equipped with 1-ton chain hoists, one of which is shown in Fig. 26. A stock of from 4000 to 7000 ranges, depending upon the time of the year, is maintained in the warehouses.

Carload shipments are loaded in cars switched to the plant on a siding from the Boston & Maine railroad at Union Market station. Stoves destined for New England points in less than carload lots are carried in 5-ton automobile trucks to Boston freight terminals, from which nightly freight service provides transportation facilities almost comparable with express service.

In tracing the various steps of stove manufacture, it was impossible to mention a number of details of plant construction and equipment that greatly influence the efficiency of stove production. In the July, 1899, issue of THE FOUNDRY, the reference to the washroom facilities of the then new Walker & Pratt plant, indicates that even 20 years ago, the company was alive to the necessity of providing sanitary conveniences for its employes. The New England molder has formed the commendable habit of effecting a complete change of attire when starting and quitting work in the foundry. To encourage the continuance of this practice, a number of unusually well-equipped washrooms have been provided for the workmen. Each man is assigned an individual locker and pegs on a clothes drying rack. An ingenious bracket affixed to the bottom of each locker door secures a galvanized iron pail which is only released when the locker door is open. These pails are used by the workmen in washing. Wash basins and shower-bath compartments are provided in each washroom.

Precautions Against Fire

The predominance of wood in foundry construction in New England has necessitated the employment of unusual precautions against fire. Although the Walker & Pratt plant is amply protected by an extensive automatic sprinkler system, hydrants, hose, etc., an additional safeguard in the form of a monthly inspection of fire-fighting equipment and the condition of the property is provided. A committee makes a tour of inspection on the fifteenth of each month, noting its findings in an inspection book, one page of which is reproduced in Fig. 23. The book eliminates errors of omission, as an answer is required showing the condition of every important detail in the plant.

Perhaps the most striking feature

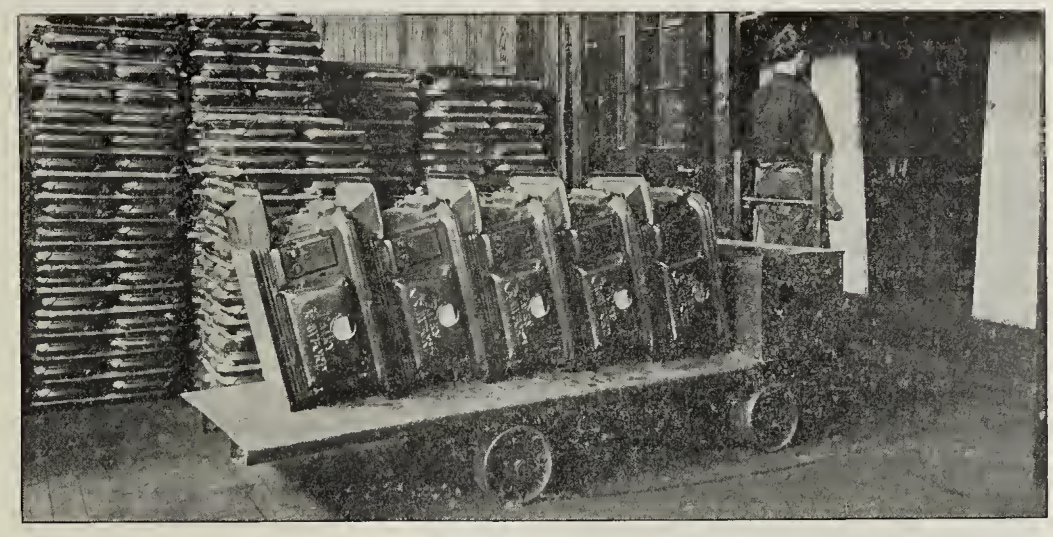


FIG. 25—STOVES ARE EASILY CARRIED ABOUT THE PLANT ON A STORAGE BATTERY TRUCK

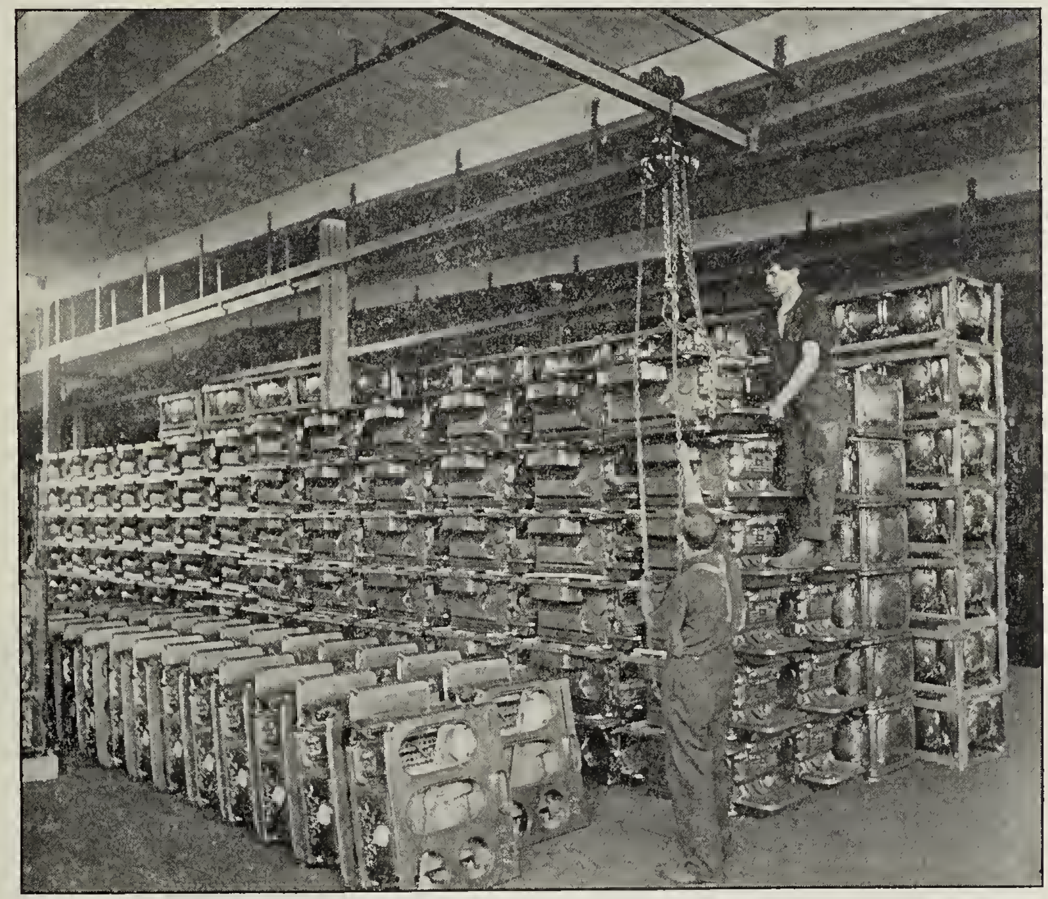


FIG. 26—A SIMPLY CONSTRUCTED TRAVELING CRANE FACILITATES PILING STOVES IN WAREHOUSE

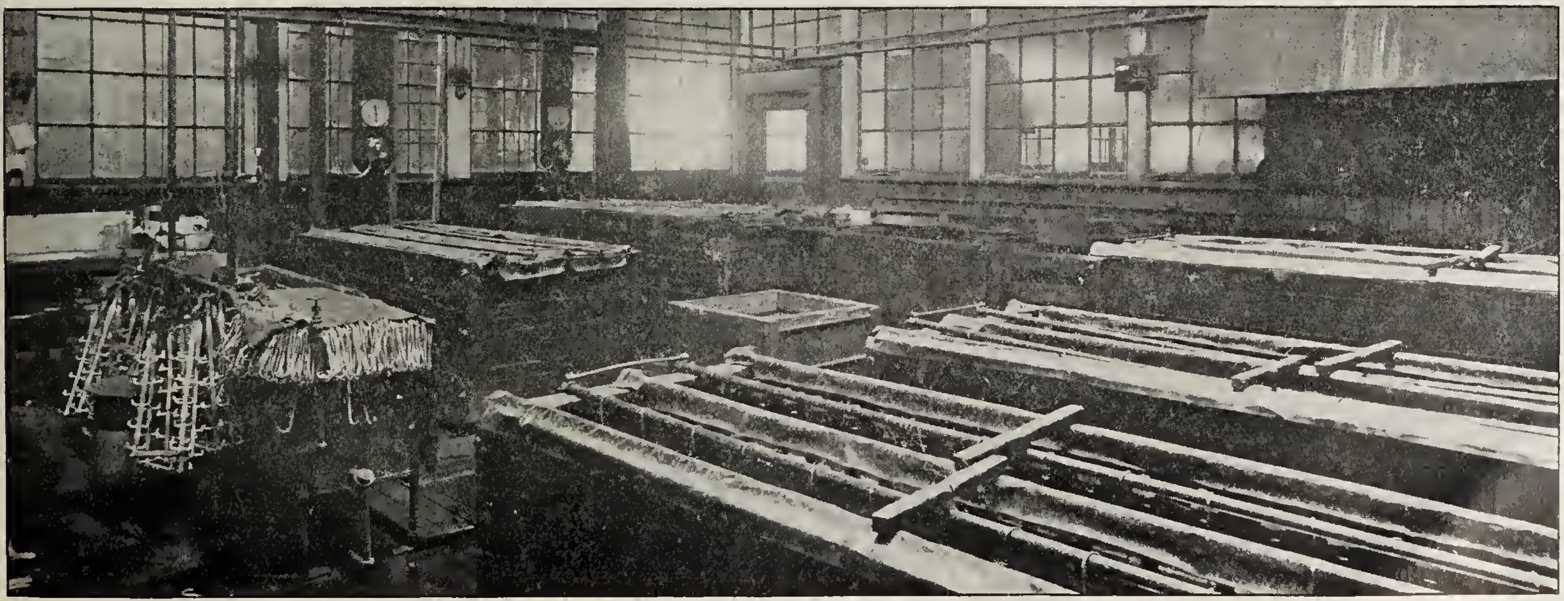


FIG. 24—A VIEW OF THE VATS IN THE NICKEL-PLATING ROOM

of the plant is the superintendent's of foundry executives have been given office. As a general rule, the offices little attention in the past, and even in many of the modern casting plants, the offices consist of rooms formed by temporary partitions in the main foundry buildings. At the Watertown stove plant, the offices occupy a separate building situated in the small park at the north of the plant. The two walks connecting the offices with entrances to the plant are roofed over and walled on one side, affording protection against the weather. The office building, as it appears from the entrance to the grounds, is shown in Fig. 3. The vestibule of the building leads to a large room which will ultimately be used for the display of stoves. The floor of this room is of tile and the walls have an oak-finished wood wainscoating. The ceiling is paneled off into squares by heavy woodwork, and electric lamps suspended in the center of each square afford indirect light. The offices proper, as shown in Fig. 2, occupy an alcove in the west side of the building. The superintendent's private office is in the corner of the building at the left in Fig. 2. Fig. 1 indicates how foresight in planning many years ago has enabled the company to develop beautiful grounds around the plant.

To Build Electric Furnaces

T. H. Watson & Co., Sheffield, Eng., have formed an American corporation to handle their electric furnace business in the United States and Canada. The Watson company controls the Greaves-Etchells electric furnace. The new American company will be known as the Electric Furnace Construction Co. and its offices will be in the Finance building, Philadelphia. Over 30 Greaves-Etchells furnaces are in operation in the Sheffield district in England, ranging in capacity from 1000 pounds to 12½ tons. The American company has already taken orders for 6-ton equipments to be installed at the United States navy yards at Bremerton, Norfolk and Honolulu. The new company will be headed by Frank Hodson, one of the partners of T. H. Watson & Co. F. J. Ryan, formerly eastern manager of the Snyder Electric Furnace Co., will be general manager of the Electric Furnace Construction Co.

The Whiting Foundry Equipment Co., Harvey, Ill., now is directly represented in Pittsburgh and vicinity by F. J. Page, located at 411 Fulton building. Mr. Page has been in the employ of the Whiting Foundry Equipment Co. for many years in both the estimating and sales departments.

New Plant of Keller Pneumatic Tool Co.

The new plant of the Keller Pneumatic Tool Co., Grand Haven, Mich., has been completed and arrangements have been made to begin the removal of the equipment from the plant at Fond du Lac, Wis., during the month of September. The new plant has been laid out in units and it is planned to remove one unit from the old plant at a time and in that way present production will be maintained. The Keller Pneumatic Tool Co. has enjoyed a rapid growth under the management of W. H. Keller, president and general manager; Wm. H. Loutit, vice president, and Arnold J. Petri, secretary and treasurer.

Performance of Melting Furnaces

In a communication to THE FOUNDRY, Harry E. Kies, manager of the malleable department of the American Radiator Co., Buffalo, states that he is now melting 72,000 pounds daily in the melting furnaces which were descrbied in detail in the article entitled "Removing Traditional Evils of Malleable Practice", published in the February issue of THE FOUNDRY. The iron is being tapped 12 to 13 hours from the time the blast is put on. The heats are run off without skimming, the slag being taken off after the iron has been tapped from the furnaces. The metal is remarkably uniform in temperature and strength and varies from 54,000 to 58,000 pounds per square inch, in tensile strength. The castings made from this metal range from the lightest malleable sections to the heaviest parts used in automobiles.

Mixture of Iron for Permanent Molds

Since the publication of the article in the July issue of THE FOUNDRY, page 274, entitled "The Early Use of Permanent Molds for Castings", by Alex. E. Outerbridge Jr., numerous inquiries have been received regarding the mixture best suited for this work.

Mr. Outerbridge states that "the analysis of the iron depends largely upon the size of the castings to be made and upon the dimensions of the molds. For small castings any ordinary foundry iron is suitable, but permanent molds made of low silicon iron, such as car wheel iron, containing from 0.60 to 0.75 per cent silicon, permanently expand or grow much less when repeatedly heated and cooled above a low red heat on the interior surface, than molds made from ordinary foundry iron containing from 1.50 to 2.50 per cent silicon. The other elements in cast iron may vary so largely without materially affecting the permanent mold, that it is not necessary to give a detailed analysis".

The Abell-Howe Co.

The Abell-Howe Co., 565 Washington boulevard, Chicago, has been incorporated to provide for the expansion of the sales and engineering organization inaugurated some months ago by Oliver J. Abell. The new company has acquired important interests in some of the manufacturing companies for whose products it will be the national distributor, and in addition, it will continue to market other equipment as sales agent. Among the products to be sold exclusively through the Abell-Howe Co., are American high speed chain and Howe detachable tongue trucks.

Oliver J. Abell is president and treasurer of the new company, Glenn G. Howe is vice president and C. E. Kane secretary. Arrangements for representation in the principal distributing centers of the country will be shortly completed.

Again Stevens Dips His Pen

This, That and Then is the title of an 80-page house organ issued by Frederick B. Stevens, Detroit, which is unique in its text since it contains a clever intermingling of light literature with trade reading applying to the business of supplying the wants of the foundry, polishing and plating industries. This pamphlet is the successor to *That and This,* published less than a year ago and which attracted considerable attention at that time. Every page of this work bears the Stevens' individuality and discusses among other subjects, "The Gugglesnack Mystery", "Billy" Sunday, "Dandy Dollar Diggers", etc.

The annual Providence outing of the New England Foundrymen's Association was held Aug. 8 at the Pomham Club, overlooking Narragansett bay. It was attended by upwards of 120 members and a typical Rhode Island clambake was served. The committee on arrangements consisted of W. A. Viall, Henry A. Carpenter and Alfred J. Miller.

H. Kramer & Co., Chicago, metal refiners, smelters and dealers, now are located in their new foundry and warehouse, built on a 1-acre site at 1324 to 1344 West Twenty-first place. Shipping facilities are provided by a side track connecting directly with Chicago, Burlington & Quincy railroad. This company purchases type dross and brass skimmings and ashes.

Melting All-Scrap in Electric Furnace

Low Phosphorus Pig Iron, Washed Metal and Steel for Casting Purposes Are Melted Interchangeably—Low Conversion Costs

By R V Sawhill

ALL-SCRAP mixtures are being used in two electric furnaces now operating in a foundry at Watervliet, N. Y., where iron and steel for the company's own castings are melted interchangeably with low phosphorus pig iron and washed metal which is sold in the open market. Remarkably low conversion costs are revealed in figures prepared at the plant.

In general foundry work it is pointed out that these furnaces enable the melter to turn out a metal of any desired carbon content starting from ordinary steel scrap. Although the cost of melting cast iron in the electric furnace undoubtedly is higher than in the cupola, it is claimed this is more than offset by the difference in the price of the raw material which the electric furnace makes it possible to use.

This furnace represents a number of years of experimental effort. The conversion loss when melting metal for steel castings is said to be less than 5 per cent. An additional factor in the cost is that the cheapest iron and steel scrap available are used for remelting. Gray iron has been satisfactorily produced to meet the specifications required from steel scrap alone. The analysis of the metal in the ladle is controlled by adding the deoxidizers and ferroalloys necessary to bring the melt within specified limits, accurate knowledge being maintained at all times of the composition of the metal so that the exact additions required can be made. An outline of the work which these furnaces have been called upon to perform is shown by the accompanying table of the average analyses of the pig iron, washed metal and castings which have been produced during recent weeks. The figures show the average analyses, but it has been found practicable to produce metal of widely different chemical composition, including grades that contain exceedingly low phosphorus and sulphur. The combined phosphorus and sul-

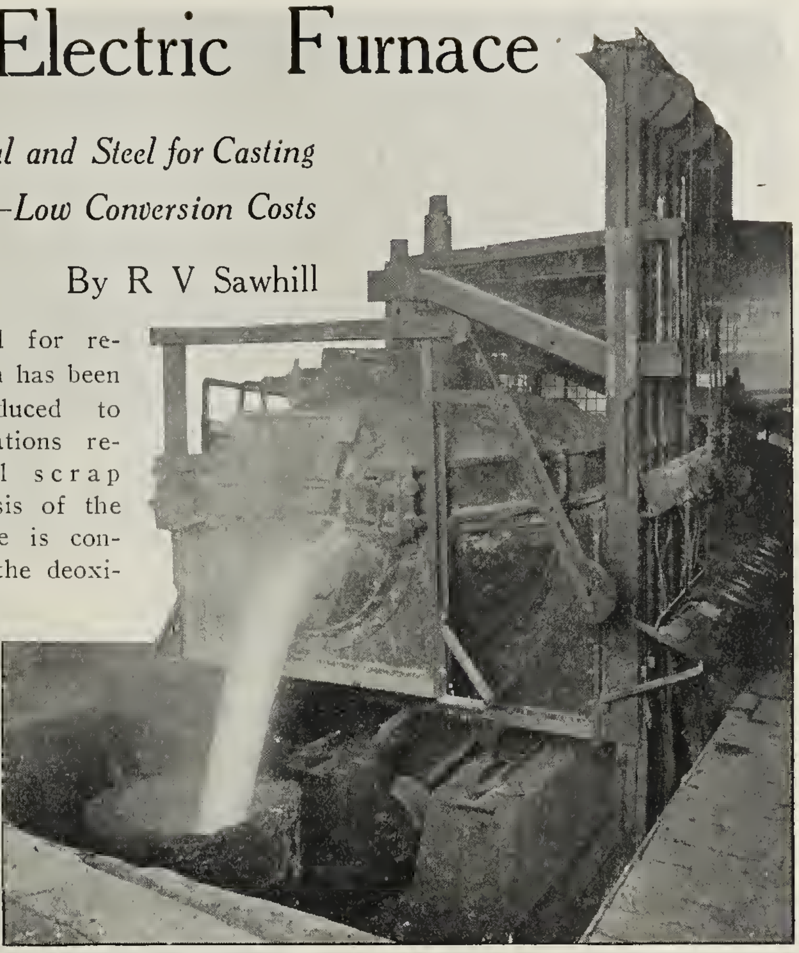


Fig. 1—Pouring Iron Turned Out From All-Scrap Mixture

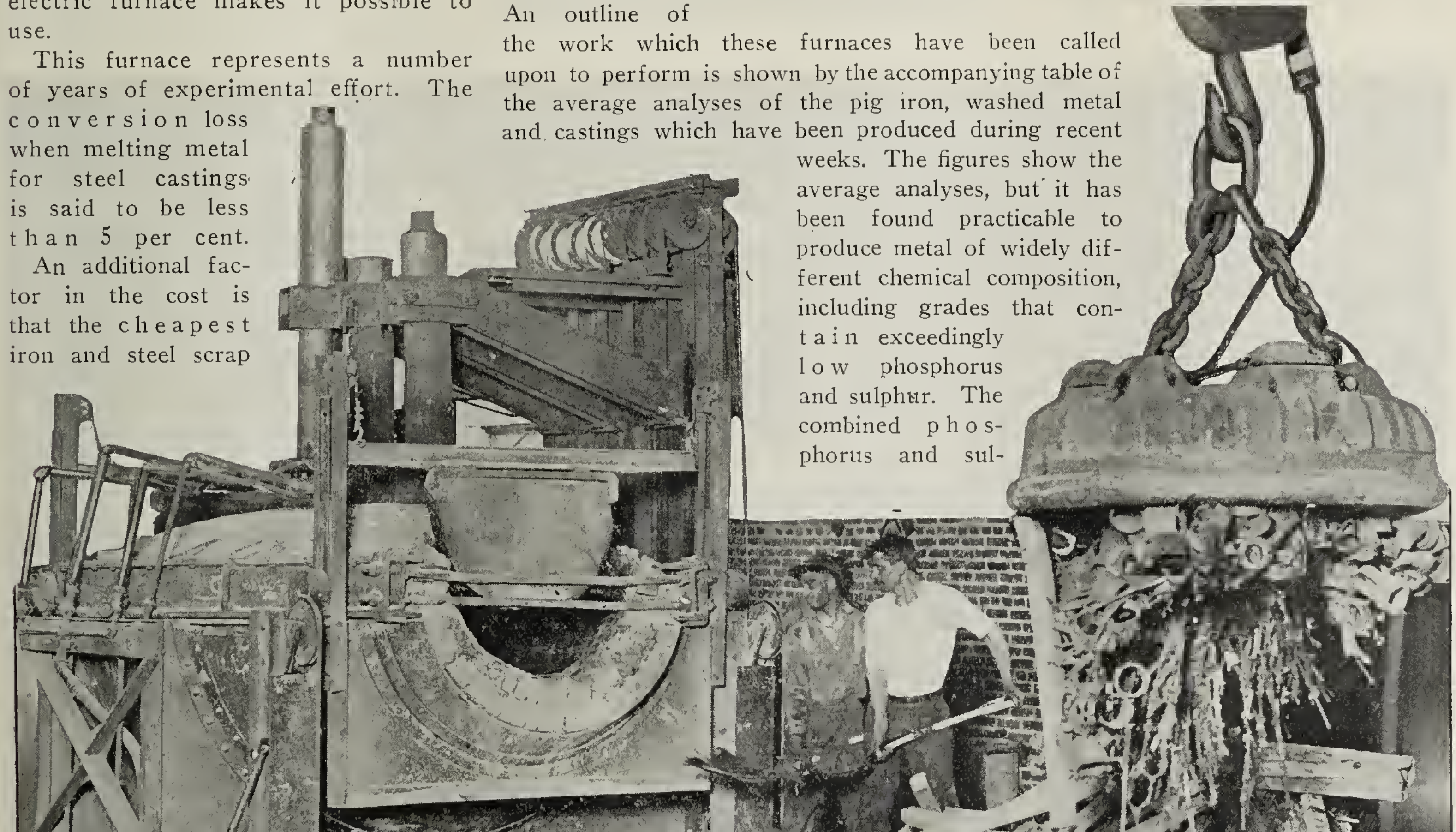


Fig. 2.—Charging is carried on simultaneously through both doors of the furnace. The magnet delivers the raw material alternately at either end, where gangs of workmen shovel it direct into the furnace.

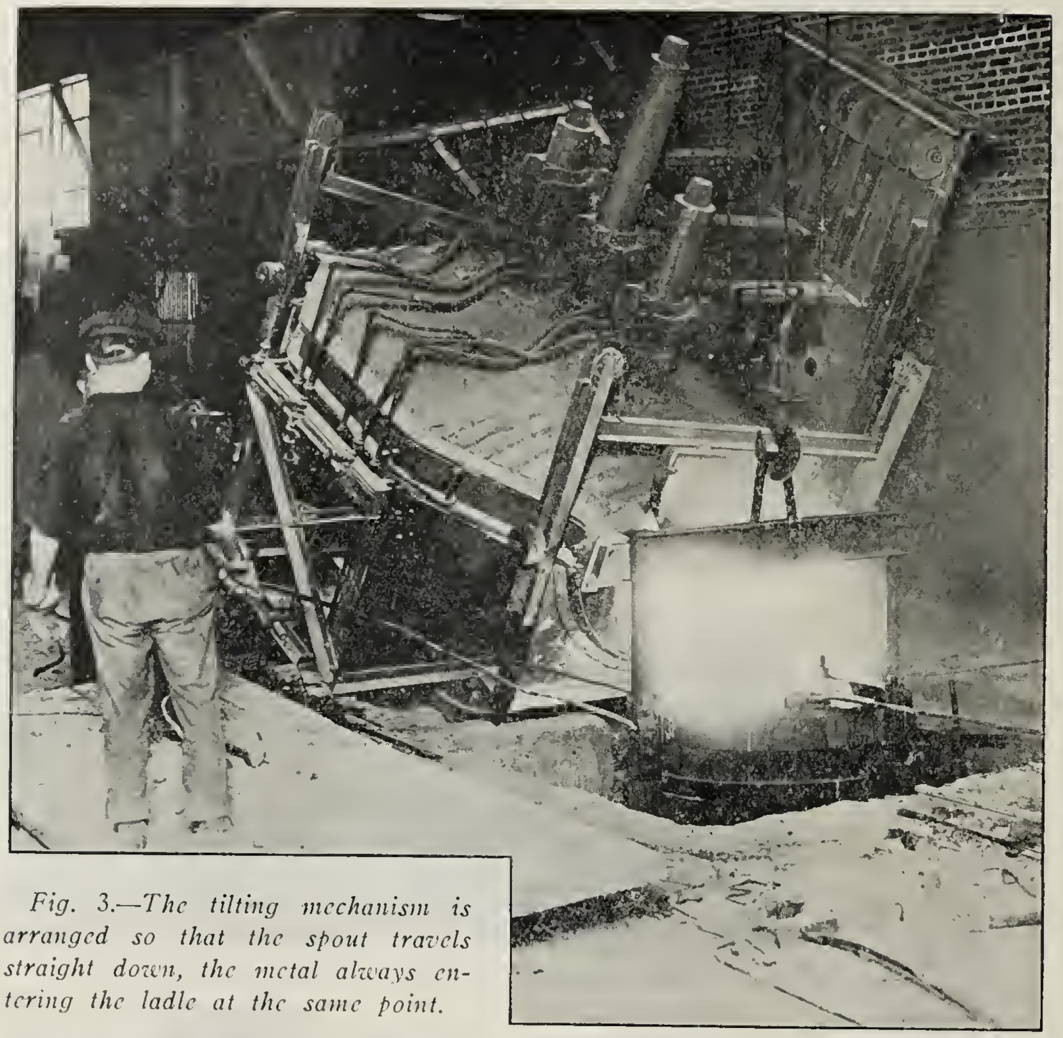


Fig. 3.—The tilting mechanism is arranged so that the spout travels straight down, the metal always entering the ladle at the same point.

phur content has been reduced to 0.015 per cent. The average analyses of pig iron, washed and casting metal made in this furnace, follow:

AVERAGE ANALYSES.

	Pig iron, per cent	Washed metal, per cent	Casting metal, per cent
Carbon	3.730	3.550	3.360
Sulphur	0.008	0.020	0.019
Phosphorus	0.030	0.014	0.024
Manganese	0.350	0.370	0.360
Silicon	1.500	0.200	1.300

The furnaces used were originally developed by the Ludlum Steel Co., Watervliet, N. Y., for producing tool steel. This company began a series of experiments some six or seven years ago under the supervision of Max Trembour, chemist in charge of melting. The Ludlum company in 1912 began to use its new type of electric furnace exclusively in all melting operations, a decision which was all the more striking in view of the company's use of crucibles for producing its high-grade steels ever since the concern was organized in 1854. The new electric furnace is described by one of the Ludlum officials as an electrically-heated crucible in which all chance for oxidation is avoided.

Mr. Trembour, when he began his experiments, started to build a fur-

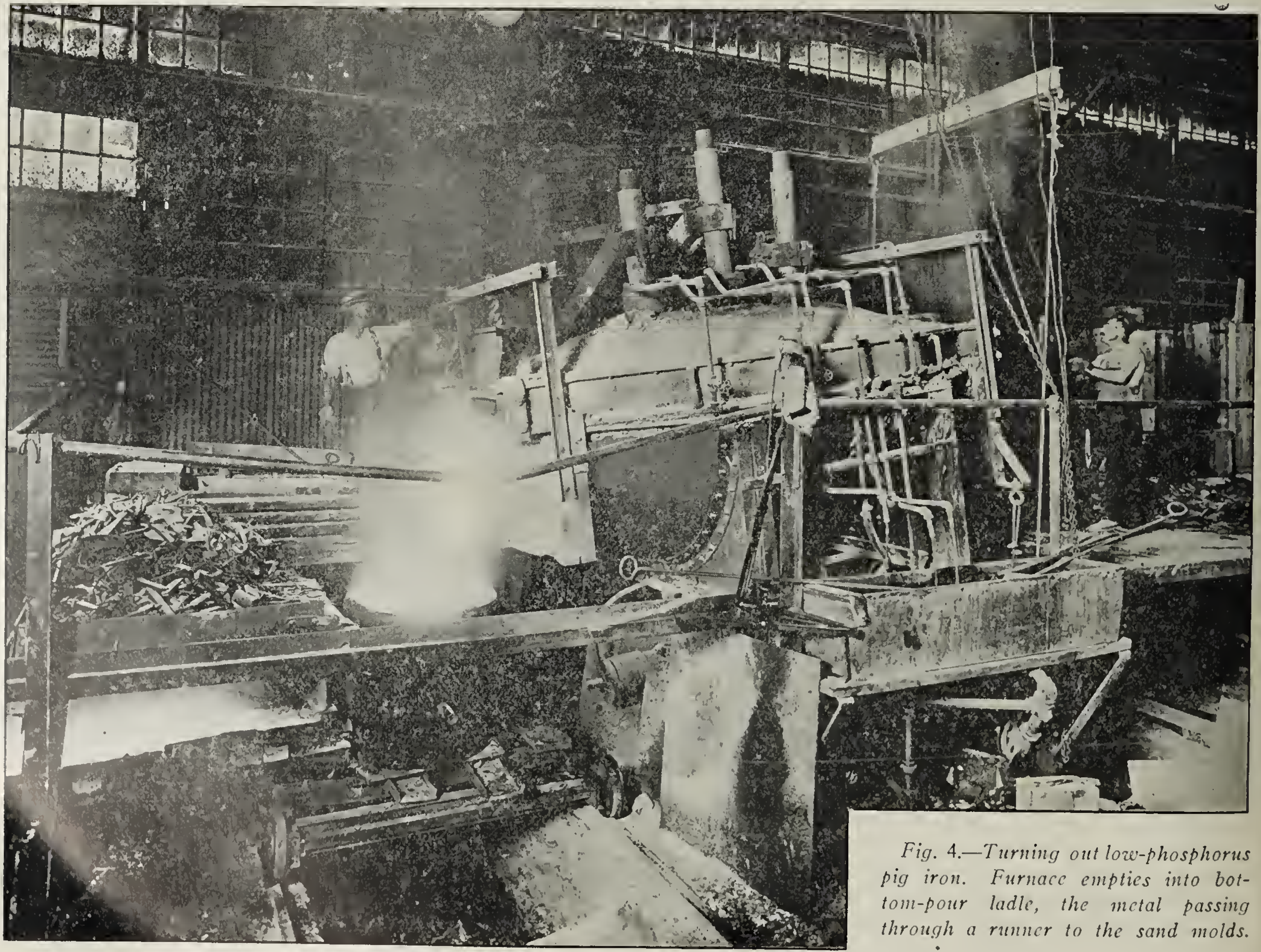


Fig. 4.—Turning out low-phosphorus pig iron. Furnace empties into bottom-pour ladle, the metal passing through a runner to the sand molds.

nace around the electrodes, rather than to adapt the arrangement of the electrodes to the shape of the furnace. His preliminary work was carried out on the assumption that the shape of the furnace was of primary importance in determining the efficiency of operation. As a result of his studies, he evolved an elliptical-shaped furnace with three electrodes arranged in a straight line. This arrangement, according to the men associated with the operation of the furnace at the Ludlum plant, effectually prevents cold spots and gives a high degree of uniformity to the heat distribution. In substantiation, these operators point to observations which have shown that when the cold fringe around the bath becomes molten all the center of the bath proves to have been thoroughly melted at the same time.

The furnace in its present form was developed only as a result of thorough experimentation with a number of original types. These included small single-phase, hexagon 3-phase and circular rotating types. After the present shape of the furnace and arrangement of the electrodes was decided upon, work was concentrated upon several small-sized units and finally upon a 1500-pound fur-

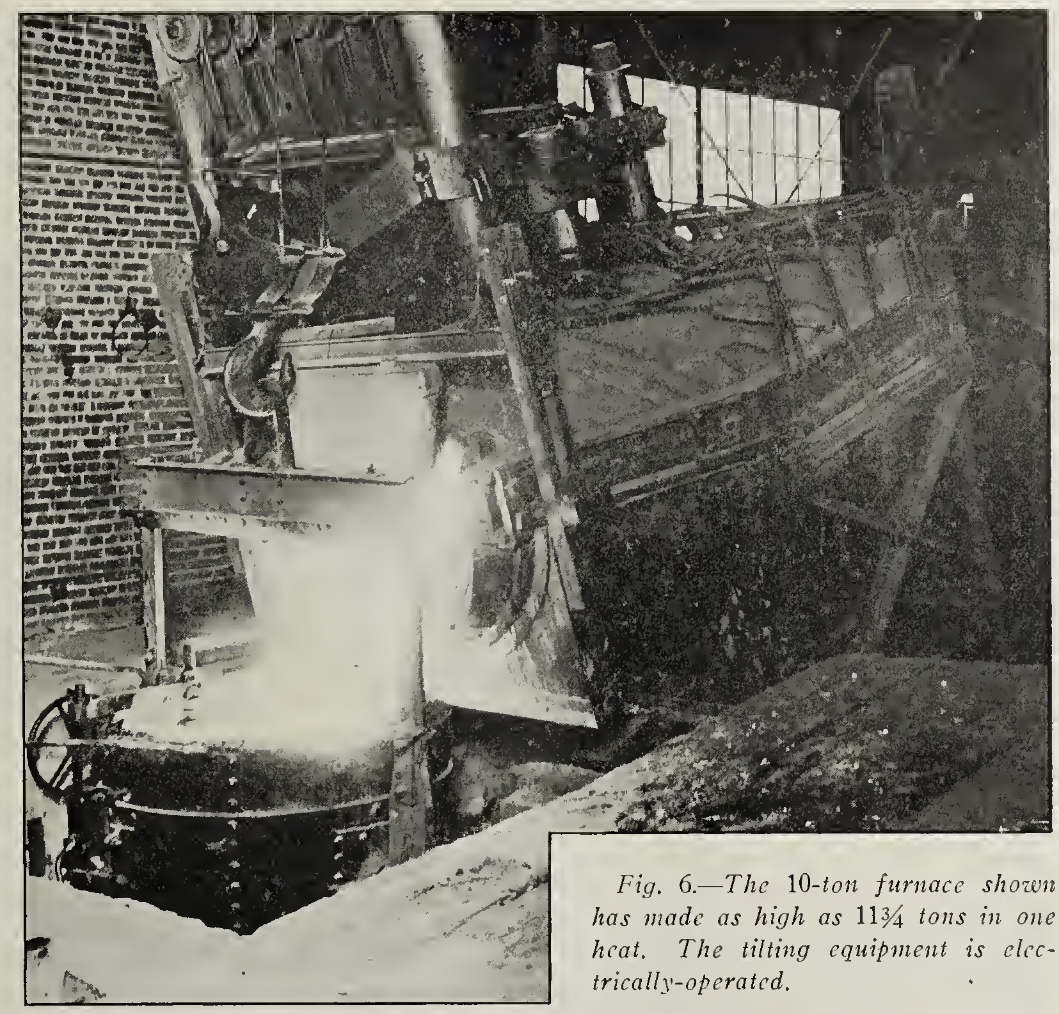


Fig. 6.—The 10-ton furnace shown has made as high as 11¾ tons in one heat. The tilting equipment is electrically-operated.

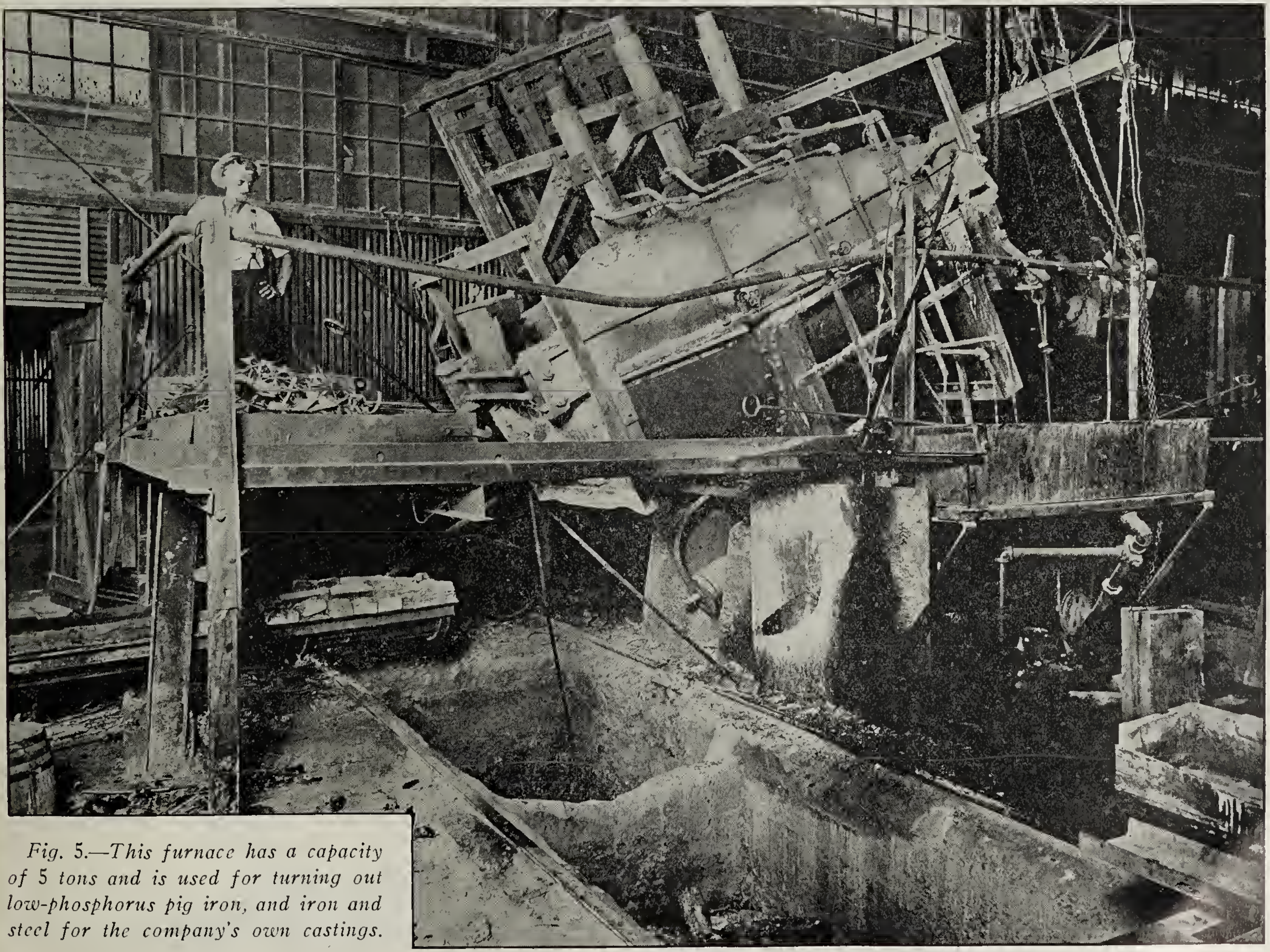


Fig. 5.—This furnace has a capacity of 5 tons and is used for turning out low-phosphorus pig iron, and iron and steel for the company's own castings.

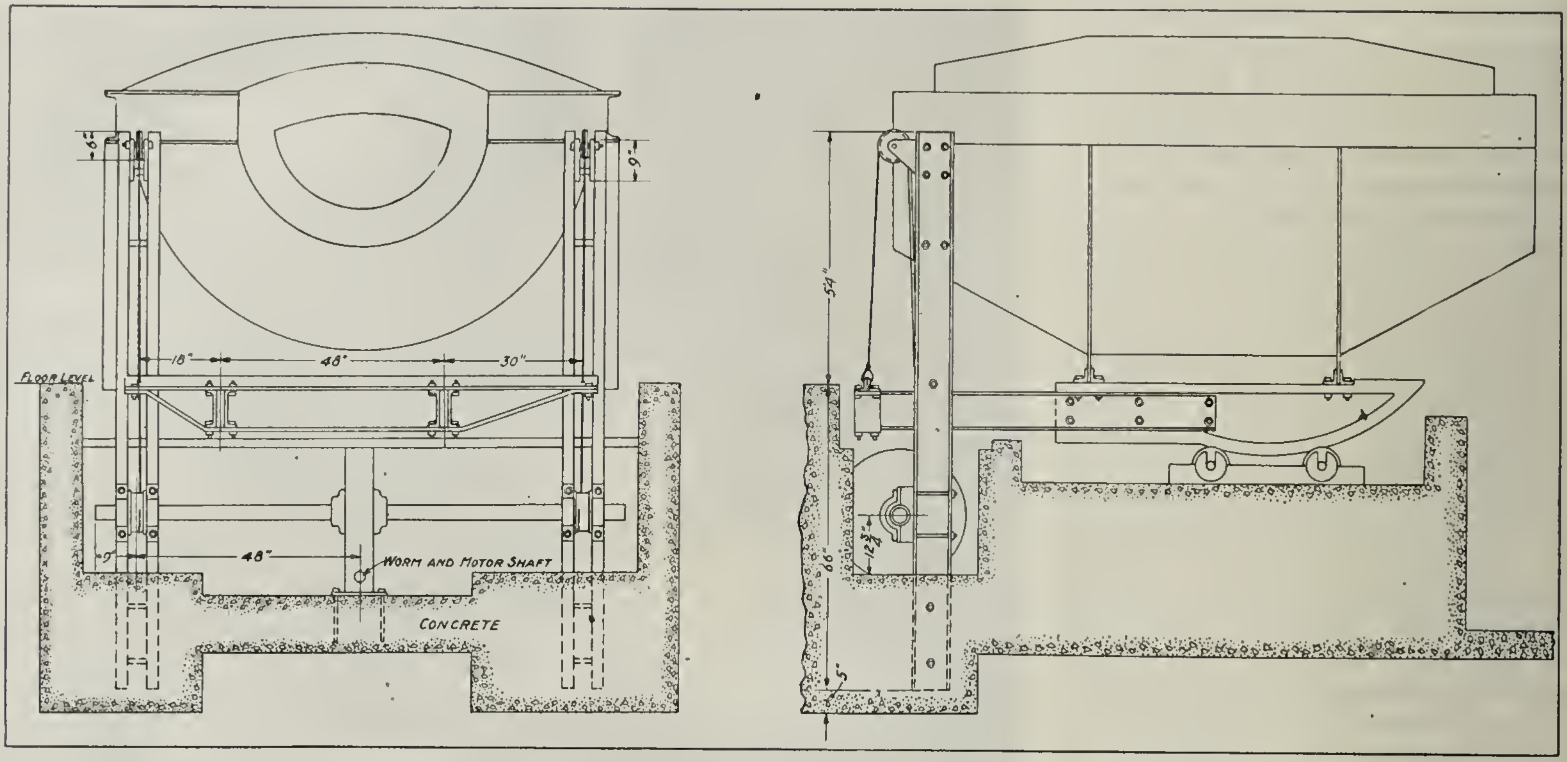


FIG. 7—DETAILS OF TILTING EQUIPMENT FOR 10-TON FURNACES

nace. The operation of this unit proving satisfactory, two 5-ton furnaces of the same design were built and these units are employed in the foundry work and in producing low phosphorus pig iron and washed metal. These furnaces are now operated under lease by the Sweetser-Bainbridge Metal Alloy Corp., Watervliet.

The Ludlum Steel Co. has used the electric furnaces solely for producing high-grade steels, as the melting units were developed not as a marketable product, but to meet the company's needs for producing larger tonnages of equal, or if possible, improved quality. Before leasing the 5-ton units, the company built two 10-ton furnaces, which it has been using in manufacturing its regular line of high-speed steel, permanent magnet steel, both chrome and tungsten, carbon tool steel, finishing steel and ball and bearing steel. The success of the venture can be measured by the rapid growth of the company during the past few years during which time it has become, in some of its lines, the largest producer in the country.

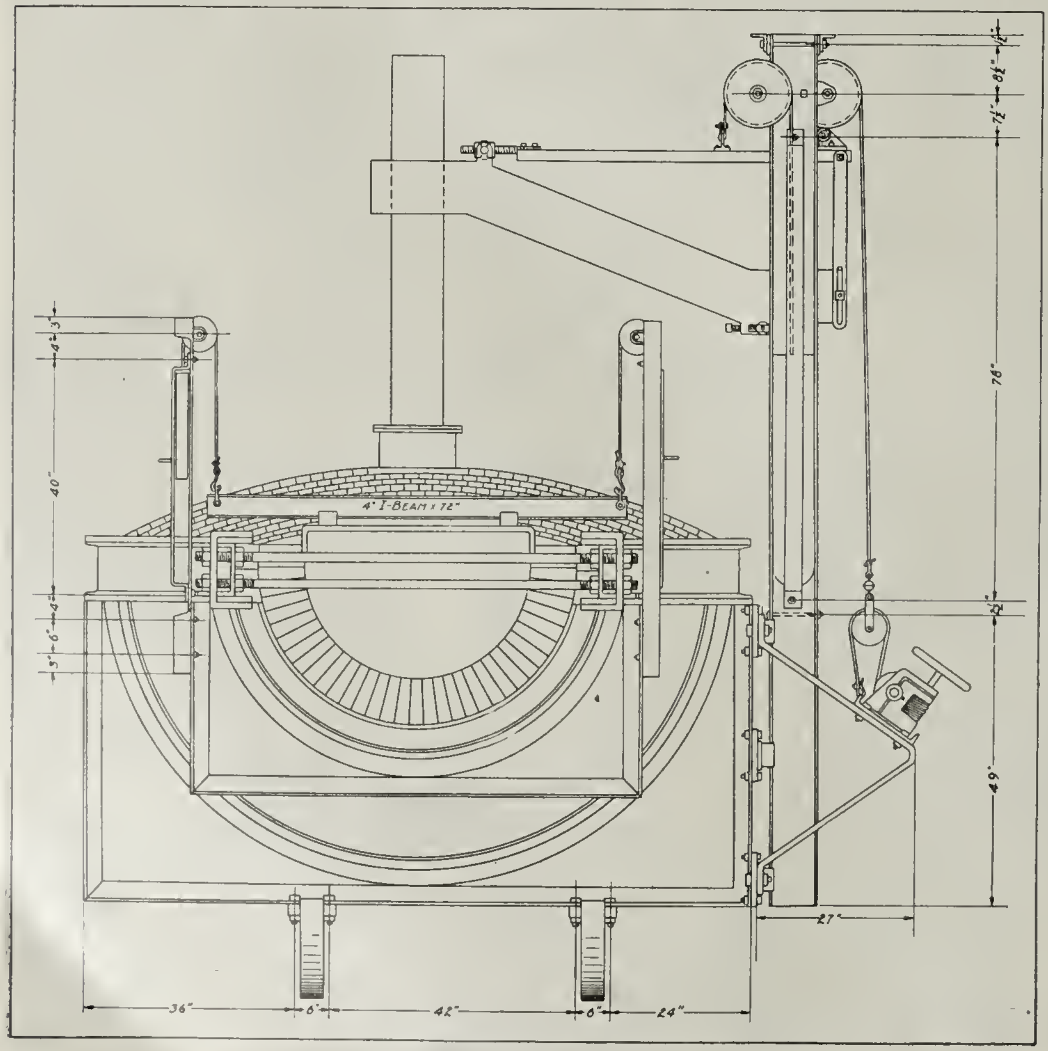


FIG. 8—FURNACE DETAILS SHOWING ELECTRODE CONTROL

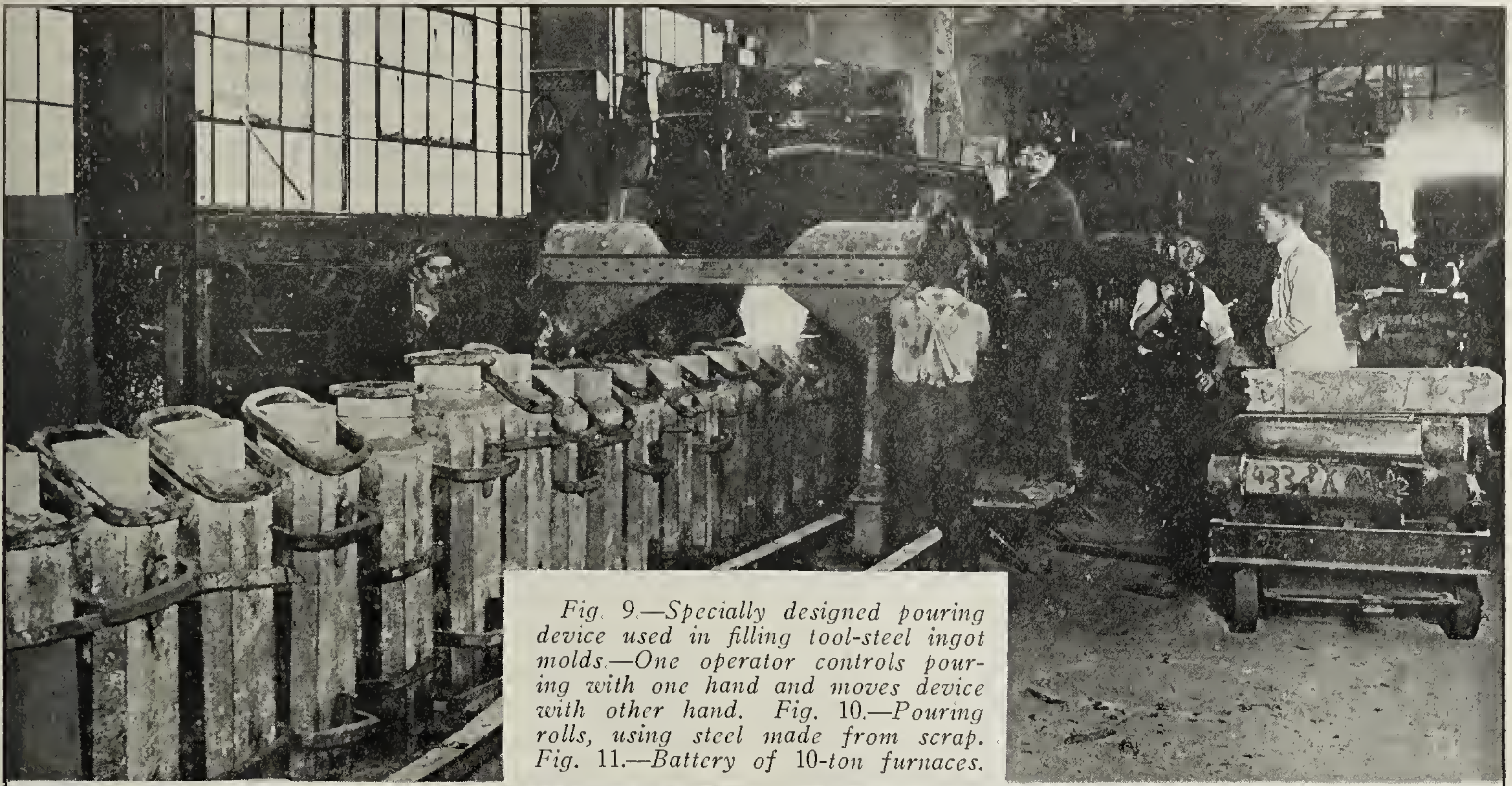
Several weeks ago a number of men familiar with the work of the electric furnaces at the Ludlum plant and the Sweetser-Bainbridge plant, formed a company to build and license these furnaces. This company has been incorporated under the name of the Ludlum Electric Furnace Corp.

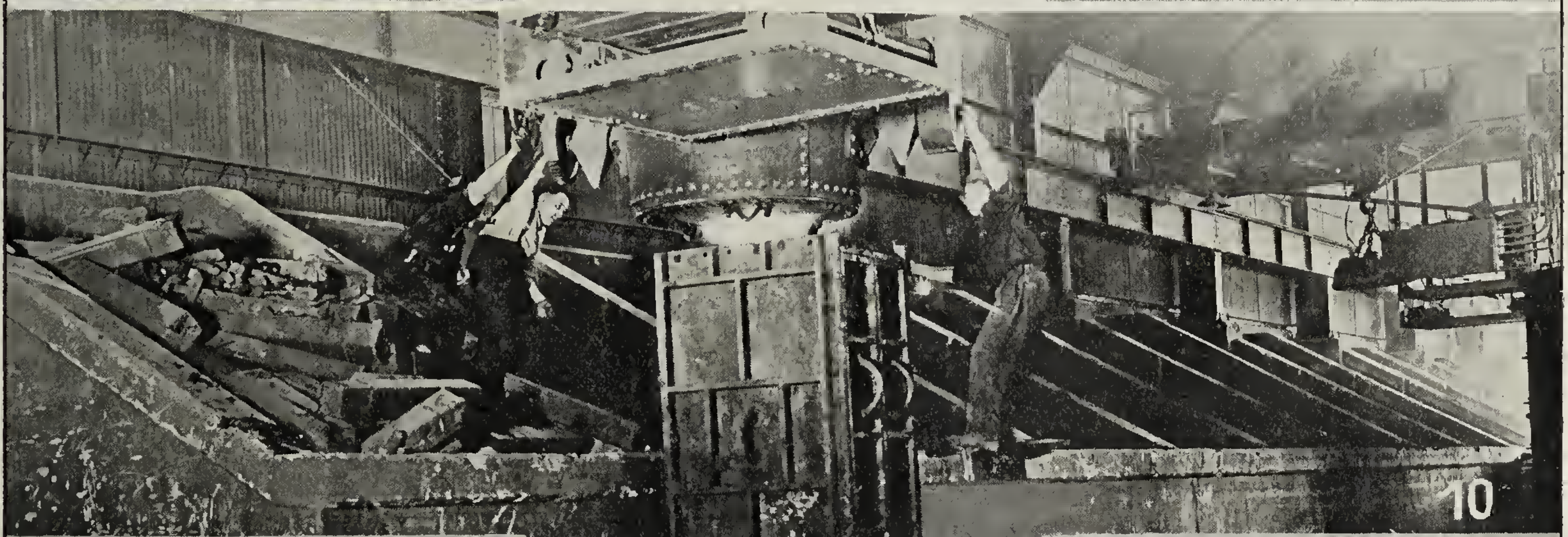
Details of the Furnace

The furnace is of the arc type, with three electrodes arranged in a straight line. Modifications in the shape are believed by the designers of the furnace to explain largely the successful results which these units have given in operation.

A clear idea of the general arrangement and details of the furnace can be gained from Figs. 7, 8 and 12. The furnace has no perpendicular walls and owing to its shape, any portion is readily accessible for repairing, or when operating, for removing the slag. The use of two doors facilitates access to any part of the furnace; both doors are used when charging, while one is employed for pouring.

Fig. 12, showing the arrangement of the busbars, transformer and cable connections, reveals clearly the method of introducing the current into the furnace. Electricity is purchased from the Adirondack Power Co. and enters the plant at 11,000 volts. It is reduced in a 1500-kilovolt ampere transformer set furnished by the General Electric Co., Schenectady, N. Y.,





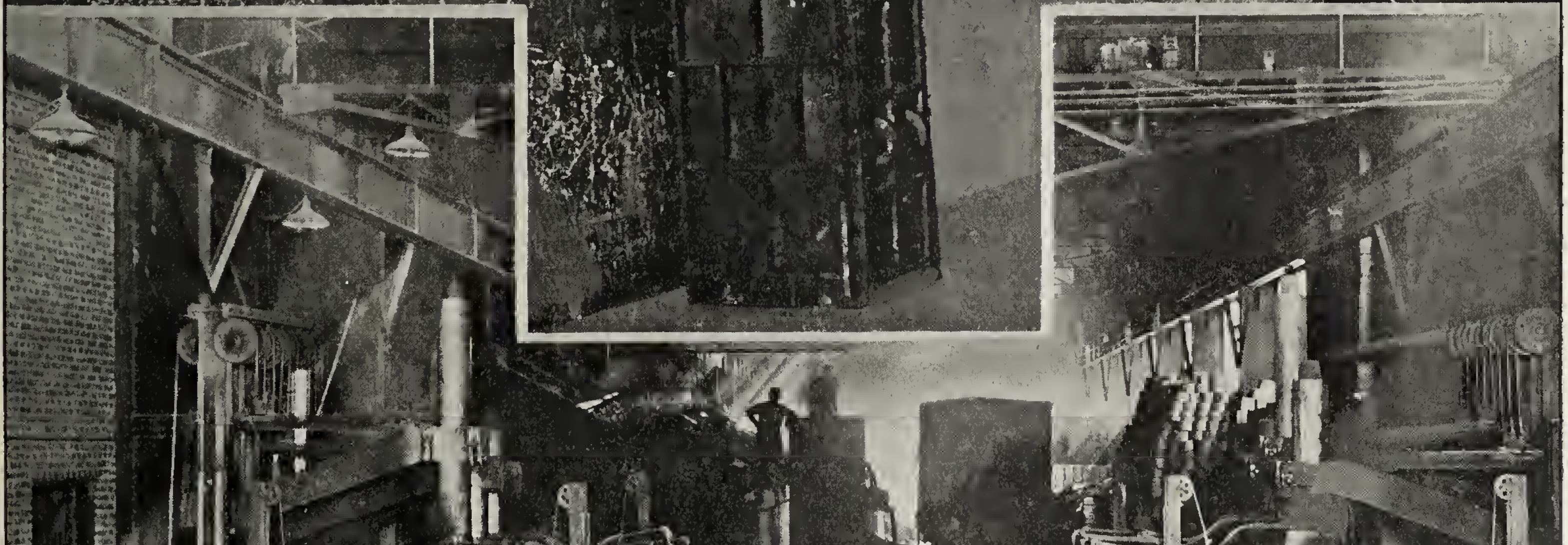


Fig. 9.—Specially designed pouring device used in filling tool-steel ingot molds.—One operator controls pouring with one hand and moves device with other hand. Fig. 10.—Pouring rolls, using steel made from scrap. Fig. 11.—Battery of 10-ton furnaces.

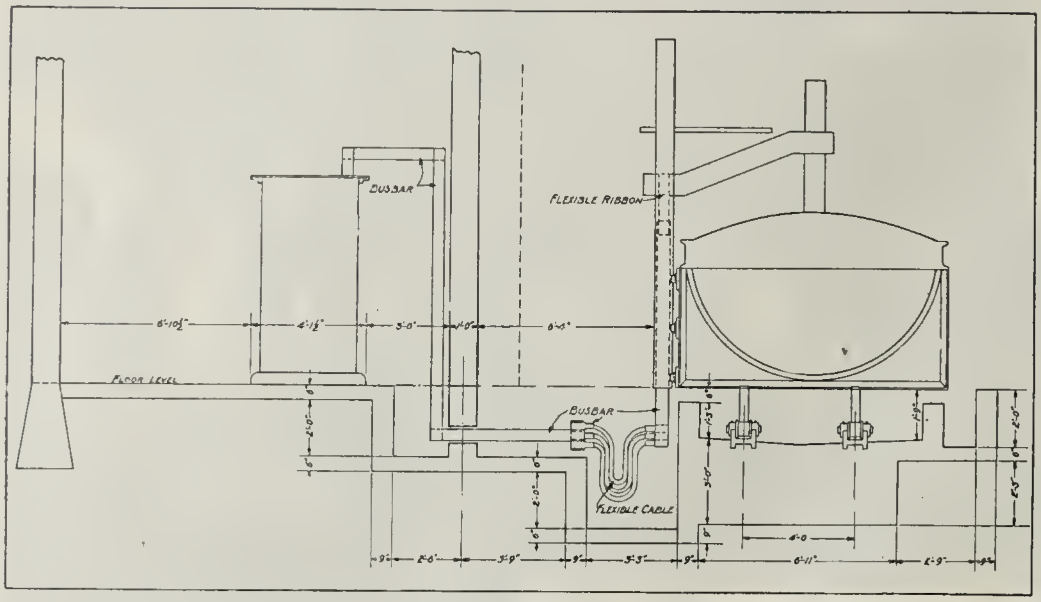


FIG. 12—ARRANGEMENT OF BUSBARS, TRANSFORMER AND CABLE CONNECTIONS

to 90, 95 and 100 volts. It is then brought to the furnace through the busbar and flexible cable connections shown. The flexible cable is provided to compensate for the tilting of the furnace.

Controlling the Electrodes

The position of the electrodes is controlled by hand wheels functioning through worm wheels and pulley, lead counterweights increasing the ease with which the hand wheels are moved. Roller bearings and set screws are employed to give greater flexibility in operating the electrode arms. The electrode holder is fastened to a rail which is raised and lowered by a cable passing over a wheel and through a pulley to the hand wheels. Plans have been prepared for installing automatic control, if desired.

The shell is 9/16-inch steel plate. The lining is comparatively thin. This, as the designer points out, is permitted owing to the uniform distribution of heat which is secured, with the consequent even wear upon all parts of the lining.

The problem of relining has been found to be relatively simple. With the 5-ton furnaces, a record of relining in 23 hours has been set. This time is computed from the minute when pouring was completed until recharging was started. One of the furnaces which was pouring when the writer visited the plant had been run for 92 heats and was still in good condition. Magnesite lining is employed, this being reclaimed after use, as ground magnesite is in demand at the Ludlum plant. The relining is usually done on Sunday, and is undertaken when it is decided that the furnace will not run through the following week.

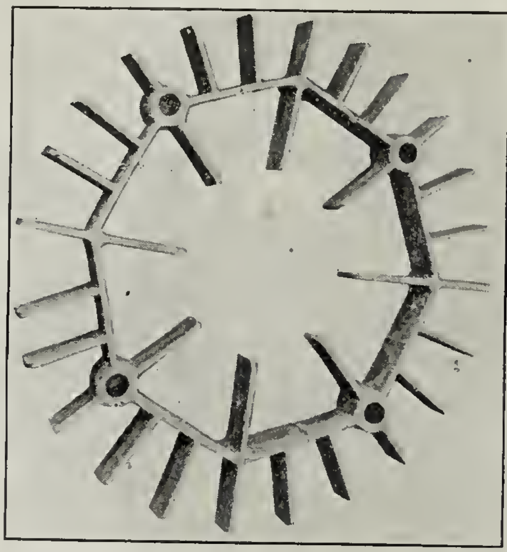


FIG. 14 — THIN-SECTIONED CASTING MADE FROM ALL-SCRAP MIXTURE

The construction of the roof is shown clearly in Fig. 13. The angle iron and independent rods are employed to take the thrust of the roof.

How Furnaces are Charged

The scrap for the 5-ton furnaces is stored close to the furnaces, all charging being carried out by hand. In the steel plant, a magnet is used to bring the raw material from the concrete bins in which it is stored according to grade. The magnet commands both ends of the furnace so that hand charging can proceed simultaneously through both doors. The complete details of charging the furnaces in the steel plant are shown in Fig. 2. The furnaces are filled to the top, packing being simplified by the ease with which all parts of the furnace can be reached.

In pouring, the 10-ton furnaces are tilted on rollers actuated by individual motors located below the floor at one end of the furnace. The arrangement of the rollers, motor and tilting equipment is shown in Fig. 7. Through the arrangement of these rollers, the spout has only a downward movement, and does not tilt either forward or backward. It was designed to keep the position of the spout in a fixed vertical plane, thus giving an even stream of metal which would enter the ladle at the same point. The 5-ton furnaces are tilted by hand, through a chain and pulley, as shown in Fig. 5.

In the Ludlum steel plant, the receiving ladle is lifted by a crane from the pit in front of the furnace and placed in a pouring device developed

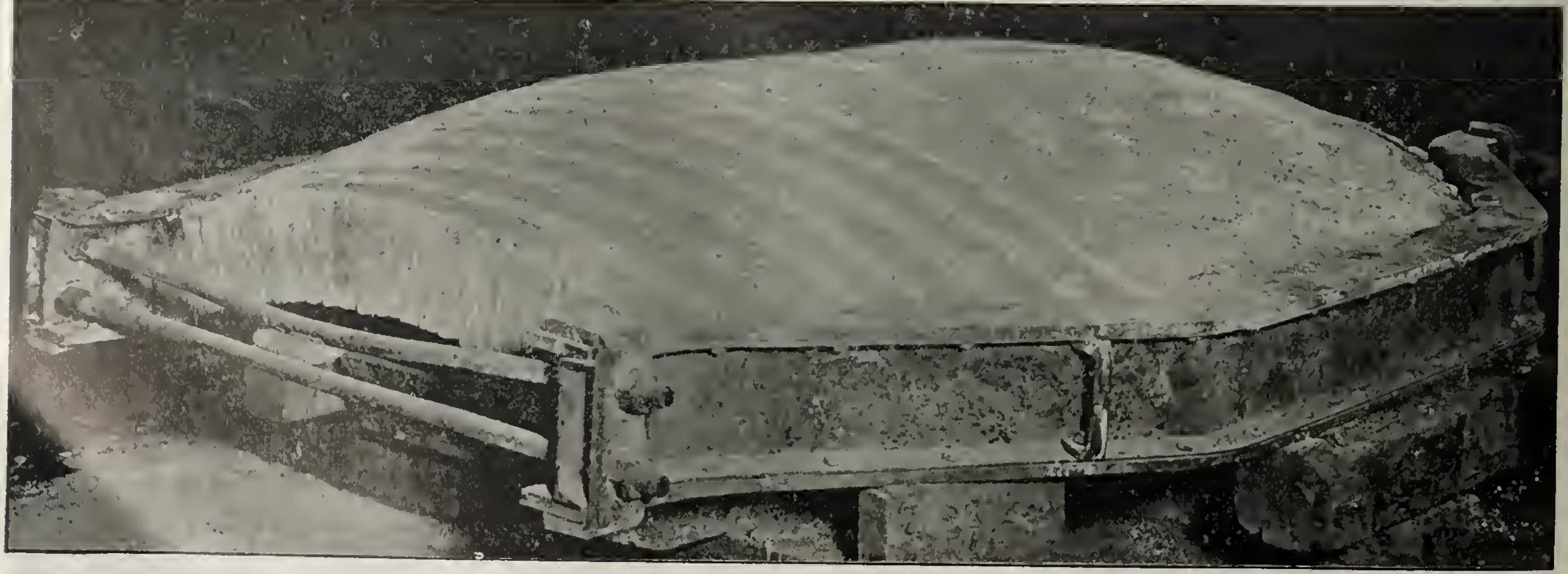


FIG. 13—SPARE FURNACE ROOF, SHOWING CONSTRUCTIONAL DETAILS

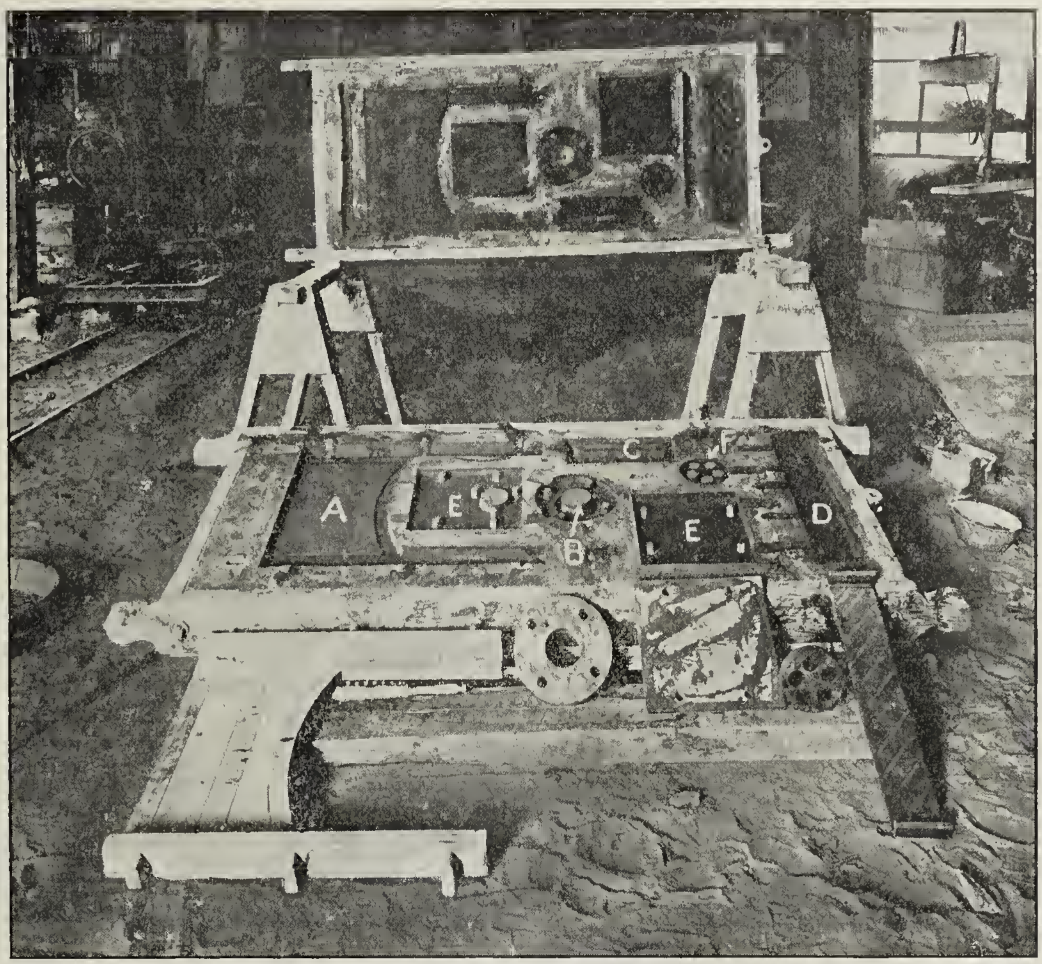


FIG. 15—DRAG AND COPE FOR GRAY IRON CASTINGS, USING MELTED SCRAP

by Thornton W. Price, an engineer associated with the Ludlum Electric Furnace Corp. Through a specially designed casting, the ladle, when placed on this device, is automatically brought into position directly over the ingot molds. The device runs on its own tracks, one operator controlling its forward movement with one hand wheel and opening and shutting the pouring spout with the other hand by means of a lever. The ingot molds ready to receive the metal as well as the pouring device in operation, are shown in Fig. 9.

In the foundry operated by the Sweetser - Bainbridge company the metal from the 5-ton furnaces enters a bottom-pour ladle, passing through a runner into the ordinary sand molds when casting pigs. When making castings, the metal is received in a 1500-pound ladle, which is controlled by a crane during pouring. The pouring arrangements in the foundry are shown in Fig. 4.

One man is employed to operate each furnace, with one melter watching several furnaces. The operators in both the steel plant and in the foundry are laborers who were trained to their work quickly and who serve under a trained supervisor. Some high production records have been made with this type of furnace, one of the 10-ton type having produced 11¾ tons in one heat.

Some of the work which is being done in the foundry is shown in Figs. 10, 14 and 15. Fig. 10 illustrates the method of pouring a large steel roll used in the Ludlum mills, two rolls being poured at one time. Fig. 14 shows a steel casting having a number of thin sections, while in Fig. 15 are the drag and cope of a mold in which seven castings are to be poured at one time. In this illustration, *A* is a furnace door frame; *B* is a bushing or a bottom-pour ladle; *C* is a rest plate for a 9-inch mill; *D* is a flask bar; *E* is a right and left oil burner plate, and *F* is a wheel for the wire straightener.

Actual foundry operations in this plant have been conducted for only a com-

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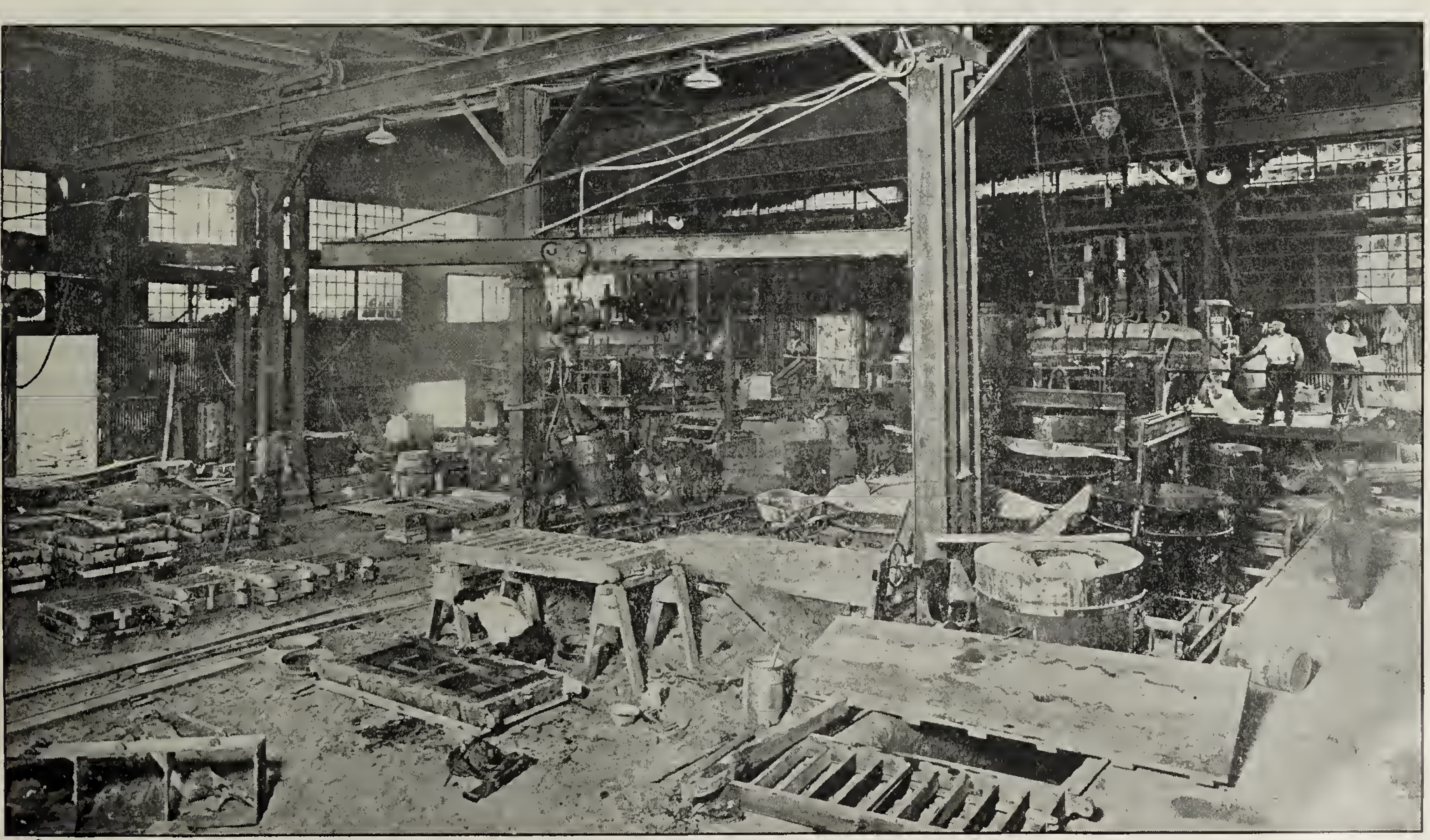

FIG. 16—INTERIOR OF FOUNDRY, SHOWING TWO FURNACES IN BACKGROUND

THE FOUNDRY

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Contents

Page
Boston Welcomes the Great Army of Foundrymen............ 343
Artistic Gray Iron Castings Made by Russian Foundrymen in the Ural Regions.............. 359
Molding and Coring a 5-Ton Gear Cutter Bed............ 363
Propeller Casting is Essential to Our Defense............ 366
Seaman-Sleeth Co. is Sold and J. S. Seaman Retires............ 369
Patternmakers' Construction Board............ 369
How THE FOUNDRY Was Dressed When It Made Its Bow 25 Years Ago 370
THE FOUNDRY Parallels Iron Industry's Progress............ 372
Gray Iron Progress in 25 Years............ 374
Progress in Foundry Equipment Manufacture............ 375
Malleable Iron Improves in Quality............ 376
Progress in Malleable Iron Manufacture............ 377
Growth of the Foundry Supply Business............ 378
How Gray Iron has "Grown" in 25 Years............ 379
Malleable Foundry's Quarter Century Survey............ 380
Supplying the Foundrymen for 25 Years............ 382
Progress of Steel Founding in 25 Years............ 383
Semisteel in the Last Quarter Century............ 384
What the Brass Foundry Has Done in 25 Years............ 386
Welding Institute Established............ 387
Pig Iron Production Declined During First Half of Year..... 387
Making Cook Stoves for Uncle Sam's New Army............ 389
To Build Electric Furnaces............ 398
New Plant of the Keller Pneumatic Tool Co............ 398
Performance of Melting Furnaces............ 398
Mixture of Iron for Permanent Molds............ 398
The Abell-Howe Co. 398
Again Stevens Dips his Pen............ 398
Melting All-Scrap in Electric Furnace............ 399
Twenty-Five Years of Service............ 406
Flag-Raising Celebrates Opening of New Plant............ 407
Improved Core Oven............ 408
Resumes Manufacture of Hoists............ 408
Personal 408
Sleeve Valve Molding Machine............ 409
New Turbine for Driving Blowers............ 409
What the Foundries are Doing............ 410
New Trade Publications............ 410

Twenty-Five Years of Service

A QUARTER of a century has elapsed since The Foundry made its bow to the trade which it has served so well, and another curtsy is in order with the inaugural of this 25-year period that undoubtedly will surpass in progress anything heretofore recorded. In a generation the industry has passed from a rule-of-thumb basis to one of scientific precision, yet many mysteries remain unsolved and much bad practice is still to be improved. The development of the art of making castings has more than kept pace with that of iron and steel manufacture, although it is without the spectacular features of the latter. While accurate figures are not available, it is estimated that the output of iron and steel castings today is two-thirds of the entire pig iron manufactured annually 25 years ago. To speculate on the future, basing calculations on the past, almost staggers the imagination. With pig iron production at the rate of nearly 40,000,000 tons, and if the increment of the last 25 years is maintained, the iron and steel foundries should be making 25,000,000 tons of castings in 1942. Stupendous and probably as unattainable as this total may seem, nevertheless this forecast is no more startling than one that might have been made in 1892 to the effect that iron and steel castings would be produced at the rate of over 6,000,000 tons in 1917. In the future, as in the past The Foundry will continue to serve the interests of every branch of the casting industry. Without the continued loyal support of hundreds of advertisers and thousands of readers throughout the world, the success of this publication would not have been possible and this celebration affords The Foundry an opportunity to express to them its warm appreciation and hearty thanks.

Everybody's Going to Boston

EVERY progressive foundryman is going to be in Boston during the week of Sept. 24. The annual meetings of the American Foundrymen's Association and the American Institute of Metals, combined with the great exhibition of foundry supplies and equipment, machine tools and accessories constitute an event that is one of the greatest and most important features of our national industrial life. The war has accelerated, rather than retarded, the interest in this great gathering of foundrymen and machine shop operators. This is proven by the increase in the number of exhibitors and the floor space reservations over the totals at Cleveland last year. Every foundryman is directly affected by the speeding-up process that is essential to victory in this crisis. He must produce more than he ever made before, and with the employment of a reduced force. This means the installation of labor-saving machinery and at Boston there will be an array of tools that will meet every requirement. The technical sessions of the conventions of the two great societies of foundrymen are replete with papers on the manufacture of munitions. Therefore it is your duty—*your patriotic duty*—to attend. And don't forget your superintendents and foremen. Give them an opportunity to go to Boston. It will make them bigger men and it will equip them to assume greater responsibilities. Others have profited by this experiment and you likewise will be the beneficiary.

Flag-Raising Celebrates Opening of New Plant

Description of the Recently Completed Works of the E. J. Woodison Co. for the Manufacture of Foundry, Platers' and Polishers' Supplies

TO CELEBRATE the completion of its new plant for the manufacture of foundry, platers' and polishers' supplies and equipment, the E. J. Woodison Co., Detroit, recently had a flag-raising on the roof of the main building, as shown in the accompanying illustration. The flag was purchased by the employes of the company and was presented to E. J. Woodison in commemoration of the event. In response to the presentation, Mr. Woodison delivered a patriotic address.

The new plant is built on a site of 1¼ acres on St. Aubin avenue and is well provided with shipping facilities. The main line of the Grand Trunk railroad parallels the rear of the property and here is also located Milwaukee Junction, which affords connections with the Michigan Central, Lake Shore, Pere Marquette and Wabash railroads. The plant has a storage capacity for 250 carloads of material and provides an area of 50,000 square feet of floor space and 3900 feet of sidetrack serve the various departments. One of the two side tracks parallels the manufacturing building, the main structure and the fire-brick storage on one side, and the other spur extends the length of the main building and brick stock house on their opposite sides. In addition, wide driveways parallel both sidings and serve the manufacturing departments and the main building.

FLAG-RAISING ON THE ROOF OF THE MAIN BUILDING OF THE NEW PLANT OF THE E. J. WOODISON CO., DETROIT

The manufacturing plant is a brick structure, 24 x 300 feet, two stories high. Manufacturing is carried on in the basement, each department being separated by fire doors and walls, and all materials are delivered to this department from the floor above by the gravity system which minimizes handling. In the basement, a large section is devoted to the manufacture of all sizes of wax vent wire. Adjoining this section is the parting compound department with a capacity of 1000 barrels per month. The raw materials are stored on the floor above and are delivered to this department by gravity. Platers' and polishers' supplies are manufactured in the adjoining section and in the next department are two 10,000-gallon tanks for the storage of vegetable oils, used in the manufacture of liquid core compound. Here also are located measuring tanks and motor-driven pumps used for the delivery of oil from tank cars for storage or for delivery to the kettles in the next section. Other motor-driven pumps are provided for delivering the vegetable oils from the kettles to the storage tanks on the main floor. The liquid core compound is boiled in four kettles which have a capacity of 140 barrels of compound per day.

On the main floor are 11 storage tanks with a capacity of 260 barrels of finished material. These tanks are so elevated that barrels or steel drums can be placed underneath them and filled direct from the tanks. Pumping facilities are provided on the siding paralleling the building for unloading cars of vegetable oils and for filling the tanks in the basement. Manholes also are conveniently located for emptying barrels of oil into the storage tanks in the basement. In the yard adjoining the liquid core compound department are two 8000-gallon oil storage tanks and immediately adjoining is a yard which has a capacity for storing several hundred barrels of rosin.

On the opposite side of the track, paralleling the manufacturing plant, is the fire brick storage, 40 x 125 feet, and 22 feet high. Providing for aisles and by piling the brick 10 feet high, this storage has a capacity of 700,000 fire brick, tile and cupola blocks.

The main building is of fireproof construction and is built of brick and concrete throughout. It is 120 x 300 feet and is devoted largely to the storage of bulky materials and miscellaneous foundry supplies. The basement is divided into 30 concrete bins for the storage of such materials as fire clay, fluorspar, brass core and sand-blast sands. A continuous monorail trolley serves all of these bins and carries a 1-ton bucket which delivers its contents to a boot at the end of the building and is elevated by an electrical hoist which dumps the contents into a hopper leading to the outside of the building where the wagons and motor trucks are loaded. A 5-ton elevator carries materials from the basement to the main floor and this likewise is employed to serve the other floors. The bulky materials for storage in the basement are unloaded direct from the cars to the bins by means of openings on each side extending the entire length of the walls.

On the main floor, foundry facings, dry core compounds and similar materials are stored. On the next floor is located the storage for miscellaneous foundry supplies and equipment, and here also has been provided a well-equipped machine shop for the manufacture of electrically operated jar-ramming, roll-over molding machines, air squeezers, brass furnaces and other foundry equipment. A large section of this floor also is devoted to the manufacture of perforated chaplets and in the wood-working department snap flasks, skim gates, floor rammers and other foundry accessories are produced. In the front end of this building are located the offices which are laid out on the individual unit plan, offices being provided for each member of the executive staff, local sales force and other departments.

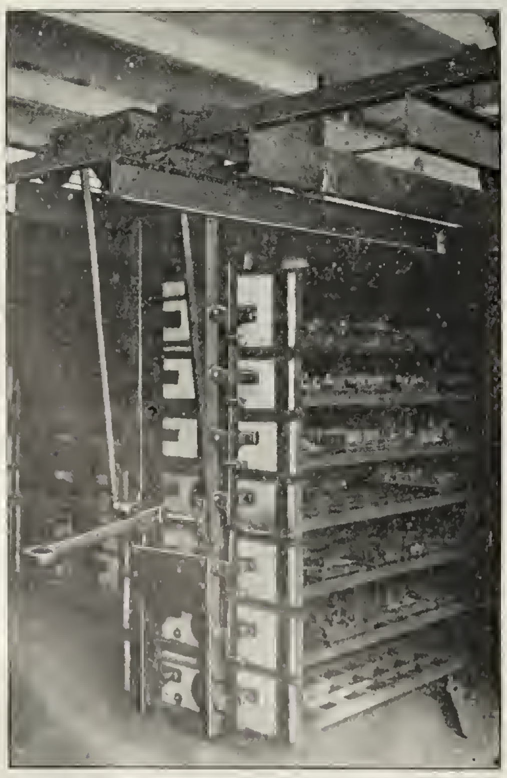
A large garage, 30 x 44 feet, also is on the property, which is equipped with machinery for making repairs on motor trucks, and tanks for the storage of gasoline and oil.

In addition to this large plant and warehouse, the E. J. Woodison Co. maintains the following branch warehouses: Toronto, Ont., with an area of 20,000 square feet of floor space; Buffalo, with an area of 17,000 square feet; Boston, with 16,000 square feet; Seattle, with 18,000 square feet, and Portland with an area of 5000 square feet. In addition, large stocks of foundry supplies and equipment are carried in warehouses located at Montreal, Que., and Windsor, Ont. Offices also are maintained in Cleveland, Indianapolis and St. Louis.

The officers of the E. J. Woodison Co. follow: President, E. J. Woodison; vice president, C. H. Woodison; treasurer and sales manager, C. D. Yahne, and secretary, J. C. Woodison.

Improved Core Oven

Improvements in the method of supporting the drawers of sectional core ovens have been developed by the Foundry Equipment Co., Cleveland, which permit the employment of standard drawer-type core oven construction with trays much larger than those customarily used. In the improved construction the double-suspension, overhead trolley, which may be seen in the accompanying illustration, supports the front ends of the drawers at two points, holding each drawer rigidly in place when it is withdrawn, and it is said, preventing sagging or swaying. The trolley travels on overhead steel beams which are anchored in the masonry of the oven. The drawers are engaged for withdrawal singly or in groups by turning a star-wheel handle which operates a separate latch for each tray. An automatic safety device prevents the trolley from releasing the drawers. This arrangement permits any one drawer or combination of drawers to be withdrawn as desired. The rear ends of the drawers are carried on differential rollers. When the drawers are pushed into the oven for baking, the front ends are allowed to rest upon the steel construction of the oven front. Ovens equipped with the new type drawer suspension have been built by the Equipment company with trays 4 feet wide and nearly 9 feet long.



IMPROVED DRAWER SUSPENSION PERMITS ALMOST ANY SIZE CORE OVEN DRAWERS TO BE USED

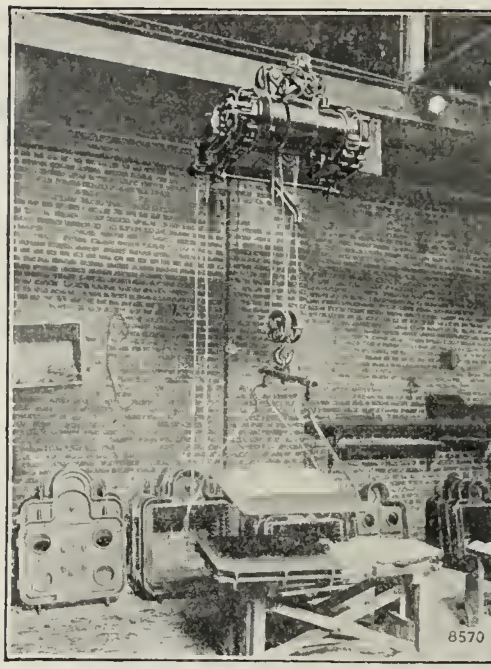


FIG. 1 — ELECTRIC HOIST HANDLING CORES IN A FOUNDRY

Resumes Manufacture of Hoists

The Link-Belt Co., Chicago, recently announced its intention of resuming the manufacture of electric hoists and will specialize in hoists ranging in capacity from 1000 to 6000 pounds. These machines, which will be manufactured at its Philadelphia plant, can be adapted for either direct or alternating current and are fitted with plain, hand-geared, cord-operated motor, or a cage-operated motor trolley. Fig. 1 shows a direct current, plain trolley hoist handling boiler cores in a foundry before the cores have been baked. The hoist employes a dynamic braking system in which the descending load drives the hoisting motor as a generator and uses it for a brake. This type of brake permits work of a delicate nature, such as the lowering of cores, to be handled with comparatively little danger of breakage from sudden shocks. All parts of the hoist are enclosed, but they can readily be made accessible. By removing a sheet steel cover the hoisting drum and controller may be reached and by removing the heads of the end housings the spur gears are exposed and may be slipped off the shafts. The cut steel gears run in oil and automatically splash lubricate the bearings. Fig. 2 illustrates a hoist handling a large pulley in a pulley manufacturing plant.

Personal

C. Albert has been appointed manager of the Southwark Bronze Co., Philadelphia.

Wm. Maginness has been appointed manager of the Christiana Machine Co., Christiana, Pa. The capacity of this plant is to be extended by the erection of an addition.

Van Buren Ropke has been elected vice president and general manager of Grainger & Co., Louisville, Ky., founders and machinists, succeeding the late W. C. Brohm.

H. D. Kenney has resigned his position as general manager of the Humphryes Mfg. Co., Mansfield, O., to become president of the Kenney-McGreevy Foundry Co., Mansfield.

E. G. Irwin, manager of the Cincinnati office of the Asbestos Protected Metal Co., Pittsburgh, has joined the

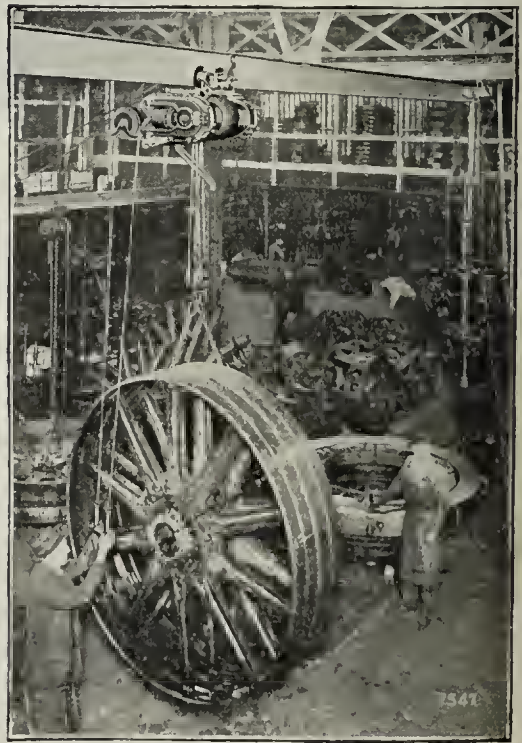


FIG. 2 — HOIST HANDLING A LARGE PULLEY IN AN ERECTING SHOP

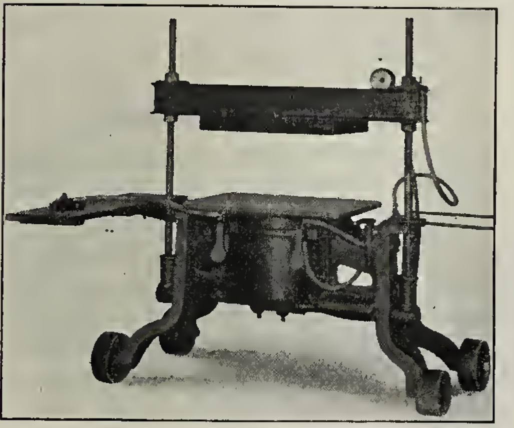
Ohio national guard and this office, therefore, has been closed temporarily.

C. D. Smith has resigned as foreman of the foundry operated by the Davis Foundry & Machine Co., Rome, Ga., to accept a similar position with the Southern Iron & Equipment Co., Atlanta, Ga.

B. M. W. Hanson has resigned as vice president and works manager of the Pratt & Whitney Co., Hartford, Conn., to accept a similar position with the Colt's Patent Fire Arms Mfg. Co., Hartford.

J. H. Jewett, formerly sales manager of the Ingersoll-Rand Co., New York, has been elected vice president and has been succeeded by L. D. Albin, formerly assistant general sales manager, who has been appointed manager.

Robert Ball, manager of the foundry operated by Butterworth & Lowe, Grand Rapids, Mich., was elected secretary of a new organization of foundrymen of western and southern Michigan, formed at the Hotel Pantlind, Grand Rapids.



SLEEVE VALVES AND LEATHER PACKING ARE FEATURES OF THIS JOLT AND SQUEEZE MACHINE

J. T. Mercer, formerly superintendent of the plant of the American Engineering Co., Philadelphia, has resigned to accept the position of works manager of the Deemer Steel Castings Co., New Castle, Del. William L. Fahnstock succeeds Mr. Mercer as superintendent of the American Engineering Co.

G. G. Reiss, formerly affiliated with the estate of P. D. Beckwith, Dowagiac, Mich., has been appointed superintendent of the new plant of the Minnesota Furnace Supply Co., St. Paul. A new foundry recently has been built by this company for the production of castings for furnaces and heaters.

Walter A. Janssen, superintendent of the steel foundry of the Bettendorf Co., Davenport, Ia., has resigned. On Saturday night, Aug. 18, he was the guest of honor at a banquet tendered to him by his former employes and as an expression of their good will and esteem they presented him with a gold watch and diamond ring. Mr. Janssen is a director of the American Foundrymen's Association and is chairman of its committee on steel foundry standards. His future affiliation has not yet been announced.

Alfred L. Holmes and C. M. Goldman have been added to the sales organization of the Pangborn Corporation, Hagerstown, Md., manufacturer of sand blast equipment. Mr. Holmes will be placed in charge of the Cleveland office of this company and Mr. Goldman will be district sales agent at Philadelphia.

Sleeve Valve Molding Machine

The use of a simple sleeve-valve which is so designed that air is admitted to the jolting cylinder during only a portion of the period of operation is a feature of a new combination jolt-ramming and squeezer machine built by the Federal Foundry Supply Co., Cleveland. The two cylinders for jolting and squeezing are concentric. The inner, or jolting cylinder, is so arranged that the piston acts as a slide valve and cuts off the supply of air when the table approaches the top of its travel. In this position, the exhaust port is opened, allowing the table to drop. This arrangement of valves is designed to economize the consumption of air. The piston operating in the outer cylinder, which is used for the squeezing operation, is supplied with a leather ring, which is held in place by a large steel washer. When air is admitted to this cylinder, it expands the leather against the walls thus reducing the leakage to a minimum. An adjustable regulating valve is provided which may be set to maintain any desired squeezing pressure. The head of the machine is carried by side rods which turn on bearings held in position by an extension of the squeezing cylinder casting. This arrangement eliminates squeezing stresses from the frame of the machine. As may be seen from the accompanying illustration, the machine is provided with knee valves for the operation of the vibrator and squeezer.

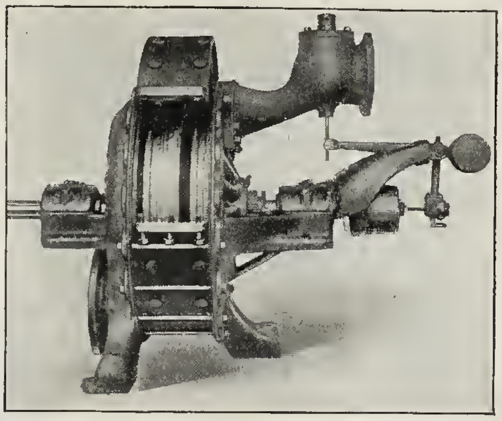
New Turbine for Driving Blowers

A series of new steam turbines suitable for use in foundries and power plants has been developed by the General Electric Co., Schenectady, N. Y. The new turbines, which are of the Curtis impulse type, are built in several capacities. The number of stages and rows of buckets vary with the capacity. When used with blowers, centrifugal fans and similar equipment, the speed of the turbine may be adjusted by means of a hand wheel while the machine is in operation. A constant running speed is maintained by a double-balanced, piston-valve throttle. A split wheel-casing, shown in the accompanying illustration, is used to permit the inspection of the buckets, which are made of bronze and are dovetailed into the wheel. The main shaft of the turbine, which runs in babbited bearings with renewable linings, is fitted with accessible packing glands. To secure rigidity, the frame of the turbine is mounted on three feet. This construction also serves to keep the bearings in line.

Melting All-Scrap in Electric Furnace

(*Continued from page* 405)

paratively short time, although the 5-ton furnaces have been producing low phosphorus pig iron and washed metal for some months. A small core oven and a dry-sand mold oven are under construction. Fig. 16 shows the general arrangement of the foundry and the position of the furnaces and molding floor.



CURTIS STEAM TURBINE WITH PORTION OF CASING REMOVED

The largest steel casting which has been poured up to the present, is a 5700-pound roll. The smallest steel casting that has been made weighs 9 pounds. The records made so far in making gray iron castings include one weighing 1450 pounds and one weighing less than ½ pound.

For commercial purposes, the furnaces are being built in four different sizes—1½, 3, 5 and 10 tons.

The officers of the Ludlum Electric Furnace Corp. are H. D. Batcheller, president; Edwin Corning, treasurer; Thornton W. Price, vice president and consulting engineer. The general offices are at Watervliet, with a branch in the Woolworth building, New York.

The Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., manufacturer of conveying and elevating machinery, has established an export department at 30 Church street, New York.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

J. C. Higgins, San Diego, Cal., will erect a brass foundry and machine shop.

The Modern Foundry Co., Cincinnati, will build an addition to its plant, 80 x 200 feet.

The Duluth Iron Works, Duluth, is building a foundry.

Plans are being prepared for a brass foundry to be erected for the Mueller Mfg. Co., Sarnia, Ont., at a cost of $100,000.

The foundry of the Gross Mfg. Co., West Hazleton, Pa., is being extended and a new pattern shop is being erected.

H. C. Trout, 226 Ohio street, Buffalo, plans the erection of a 52 x 83-foot foundry and a 40 x 50-foot blacksmith shop.

A machine shop, 106 x 400 feet, will be erected by the Aluminum Castings Co., Detroit, at a cost of $400,000.

The Sivyer Steel Casting Co., Milwaukee, will greatly enlarge its plant and will install a three-ton electric furnace.

The Cope Pattern Works & Foundry Co., Detroit, will erect a 1-story plant at 111 Wight street, to cost $32,000.

An addition, 40 x 60 feet, will be built to the foundry of the Specialty Brass Co., Kenosha, Wis.

The Belle City Mfg. Co., Racine, Wis., is erecting a foundry and wood shop at a cost of $25,000.

The Flint Foundry Co., Flint, Mich., will build a 50-ton foundry. F. L. Carpenter is manager.

The Akron Rubber Mold & Machine Co. contemplates the erection of a foundry at Barberton, O.

A contract has been awarded for the erection of a $25,000 foundry, 75 x 200 feet, by the Driver-Harrison Co., Harrison, N. J.

An addition to the foundry of the Muskoka Foundry Co., Bracebridge, Ont., will be built at a cost of $15,000.

The Eagle Brass Foundry, Seattle, is erecting a two-story, 90 x 105-foot plant at a cost of $10,000.

A. H. Burchard, Pontiac building, St. Louis, is in the market for malleable foundry and pattern shop equipment.

The Edward Valve & Mfg. Co., Chicago, contemplates the erection of a steel foundry, 80 x 100 feet, to cost approximately $30,000.

D. H. Redmond, Philadelphia, and others have incorporated the Hamburg Foundry Co., Hamburg, Pa., with a capital stock of $50,000.

The Wilcox, Crittenden Co., Middletown, Conn., will build a 40 x 90-foot foundry, of steel and reinforced concrete construction.

The American Hardware Corp., New Britain, Conn., will erect a new foundry to replace the one recently destroyed by fire.

The Marine Pipe & Machine Works, 579 Railroad avenue, Seattle, will erect a two-story foundry and machine shop at a cost of $15,000.

The Bolles Iron & Wire Works, 288 East Milwaukee avenue, Detroit, is building a $6000 addition to its foundry and boiler room.

The Independent Foundry Co., West Allis, Wis., will erect a gray iron foundry, 75 x 110 feet, at a cost of $20,000, to be located at Fifty-fourth avenue and Burnham street.

The Peoria Malleable Castings Co., Peoria, Ill., has purchased a 16-acre site on which it is erecting two buildings, respectively 120 x 200 feet and 100 x 220 feet.

A contract has been awarded by the Maryland Brass & Metal Works, Baltimore, for a foundry, 46 x 90 feet, to cost approximately $15,000.

The Hamilton Foundry & Machine Co., Hamilton, O., contemplates the erection of an addition to its plant to cost approximately $5000.

Contracts have been awarded by the Thompson Mfg. Co., Lancaster, N. H., for the erection of a 34 x 52-foot foundry to cost $20,000.

The American Die Molded Casting Co., Chicago, has been incorporated with a capital stock of $5000 by Paul J. Keck, Ignatz Lowey and Leonard H. Wolf.

The Calumet Machine & Casting Co., Chicago, has been organized with $250,000 capital stock by Harry Lewis and Samuel C. Rowland.

The Lake Charles Iron Works, Inc., Lake Charles, La., has been formed by the consolidation of the Warren Machine Works and the Leesville Iron Works, Leesville, La. A new foundry and machine shop will be built.

A company has been organized by A. W. Snyder, formerly of Burlington, Wis., to engage in the manufacture of castings and automobile parts in Milwaukee. Plans have been prepared for a two-story, 120 x 240-foot plant to cost approximately $75,000.

The Empire Stove & Furnace Co., Owen Sound, Ont., has been incorporated to engage in the manufacture of stoves, furnaces, radiators and castings. The new company is capitalized at $100,000 by Archibald A. Parks, Abraham J. Creighton and Edgar W. McQuay.

The Nicu Steel Corp., Toronto, Ont., has been incorporated with a capital stock of $200,000 to conduct foundries, iron and steel plants, etc. The incorporators are Donald R. Hossach, 44 King street west; Joseph M. Gordon, Alicia Hill and others.

Stanley F. Kadow, architect, 988 Kinnickinnic avenue, Milwaukee, has prepared plans for a foundry and machine shop to be established in Cudahy or St. Francis. The main building will be 80 x 163 feet, with a wing, 20 x 163 feet. The name of the owner is withheld.

A company has been formed by St. Louis and Alma, Mich., interests to purchase the stock of the Standard Foundry Co., St. Louis, Mich. Officials of the Republic Truck Co., Alma, own a majority of the stock and castings for the Republic company will be the principal product. The capacity of the plant will be more than doubled.

The Kenney-McGreevy Foundry Co., Mansfield, O., recently incorporated with $20,000 capital, has purchased the plant of the Phoenix Electric Co., which it will remodel. H. D. Kenney is president of the company; Joseph Paule, vice president; Andrew Kass, second vice president; Hugh McGreevy, secretary and Jacob Cousins, treasurer.

The Temple Malleable Iron & Steel Co., 312 Harrison building, Philadelphia, will erect the following buildings at its plant in Temple, Pa.: One-story office building, 50 x 46 feet; carpenter and pattern shop, 36 x 90 feet; locker building, 41 x 52 feet; power house, 60 x 81 feet; shipping and annealing building, 95 x 236 feet; malleable foundry, 156 x 285 feet; hard iron building, 36 x 170 feet and a sand shed, 24 x 115 feet. The cost of this construction will be approximately $500,000.

The Lewis Electric Welding & Mfg. Co., Toledo, O., was incorporated recently with $100,000 capital to take over the business of the Lewis Foundry Co. A new building, 36 x 120 feet, has been erected and a building, 36 x 100 feet, is nearing completion. Several thousand dollars will be expended for equipment. The company is specializing in the production of semi-steel cast head valves for gas, gasoline and oil engines and upon the completion of the extensions will be able to double its present output.

New Trade Publications

OXY - ACETYLENE WELDING AND CUTTING APPARATUS.—An 8-page bulletin published by the Prest-O-Lite Co., Inc., Indianapolis, illustrates and describes the complete line of apparatus manufactured by this company for oxy-acetylene welding and cutting. Not only is the equipment shown, but all of the accessories required for this work are illustrated and described.

FOUNDRY EQUIPMENT AND SUPPLIES.—One of the most comprehensive catalogs yet published, devoted exclusively to foundry and platers' equipment, supplies and accessories, has been issued by the E. J. Woodison Co., Detroit. It contains 560 pages in addition to a well arranged 16-page index. This catalog will prove a valuable addition to the trade library of every foundry and plating plant. The introductory pages are unique, as they contain the individual portraits of the entire Woodison organization. The catalog is well arranged, beginning with sand, and is followed by facings, core compounds, core binders, parting compounds, fluxes, alloys, etc. Succeeding pages are devoted to small foundry supplies, such as brushes, riddles, rammers, bellows, shovels, forks, sprayers, chaplets, mallets and other small supplies required by every foundry. A number of pages are devoted to flasks, steel bottom plates, clamps and follow boards, and this is succeeded by equipment for the sand-blast room. Several pages are devoted to ladles, cupolas, blowers, etc., and one section is devoted to equipment for the core room. Hoists of various types are illustrated, as well as machinery for the pattern shop. The cleaning room is not overlooked and includes such equipment as sand-blasts and tumbling mills, as well as air compressors for furnishing air for the various foundry departments. Molding machines, fire brick and cupola blocks are featured. This work also contains a complete catalog of platers' supplies and equipment, 154 pages being devoted to this section. In addition, the catalog contains many valuable tables, hints and suggestions for gray and malleable iron, steel and brass foundrymen, as well as for polishers and platers.

The FOUNDRY
October 1917
CLEVELAND, OHIO.
Vol. 45, No 10 Whole No. 302

Spirit of Service Pervades Foundry Meeting

American Casting Industry, In Ringing Resolutions Adopted at Boston Convention of Allied Associations, Pledges Its All to Win the War

BENJAMIN D. FULLER
General Superintendent, Westinghouse Electric & Mfg. Co., Cleveland, Elected President of the American Foundrymen's Association at the Boston Convention

CONSONANT with the spirit of the great enterprise on which our country is launched, the keynote of the 1917 convention of the allied foundry organizations, held in Boston during the week of Sept. 24, was unstinted, unmeasured service to the government concentrated to one end —*victory*. Foundrymen were present from all sections of the United States, from the rocky hills of Connecticut to the far flung shores of the Pacific ocean. Without exaggeration it may be said that Boston entertained the most representative body of casting manufacturers in the history of modern foundry development. In the minds of all, the idea of service was uppermost. This theme recurred again and again throughout the week. It was specially emphasized in the annual addresses of Presidents Pero and Jones, in the annual report of the board of directors of the American Foundrymen's association, in the paper on cast-iron shells by Major Edgar Allen Custer, in the resolutions adopted at Thursday's session, in the banquet addresses of Judge Moore and John A. Penton, and in the comprehensive paper on the details of ordnance construction presented by Major C. M. Wesson of Watertown arsenal. In addition, the same thought of organizing for maximum effort to win the war underlay the proceedings of the American Institute of Metals, which devoted an entire session to the use of nonferrous metals in munitions. Finally, in his concluding remarks as presiding officer of the convention, J. P. Pero, retiring president of the American Foundrymen's association, pledged the resources and enterprise of the foundrymen of the country to the solution of every problem in casting manufacture that the war's demands may bring to the front, insofar as such problems may be made to yield to continued, concentrated attack by trained minds backed by ample equipment and unlimited funds. In his brief speech of acknowledgement, following his induction into office, Benjamin D. Fuller, the newly elected president of the A. F. A., reiterated Mr. Pero's pledge and touched on the splendid co-operation that may be expected from every casting manufacturer. The attendance at the Boston convention was larger than at any previous meeting of the allied foundry organizations. The total registration of the American Foundrymen's association was 1179, that of the Institute of Metals was well over 100, the registration in the exhibition department was approximately 1800, and the total attendance during the week, therefore, in excess of 2500. The program was replete with interesting papers, addresses and discussion. There were 55 titles on the American Foundrymen's association program and 36 on the schedule of the Institute of Metals. The preprinted papers distributed by the American Foundrymen's association at the various technical sessions aggregated 650 printed pages, the largest number in the history of the organization. The twelfth annual foundry and machine exhibition went "over the top" with a vengeance. With 163 exhibitors, whose displays fully filled both great floors of the Mechanics' building, the show eclipsed all previous attempts. It was the second exhibition conducted under the joint auspices of the American Foundrymen's association and the American Institute of Metals, and its success confirms the wisdom of the innovation launched last year at Cleveland. A complete description of the exhibition follows this report.

With an impressive flag-raising ceremony on the stage of the Grand Hall of the Mechanics' building, the twenty-second annual meeting of the American Foundrymen's association and the twelfth annual foundry and machine exhibition were formally opened at 3:00 p. m., Monday, Sept. 24. Following the flag-raising, the address of welcome was made by the Hon. James M. Curley, mayor of Boston. In addition to the usual felicitations, Mayor Curley complimented the iron, steel and foundry trades on their magnificent support of the war. He also expressed himself as warmly in favor of the settlement of price fixing problems on a basis equitable to producers and designed to stabilize wages and stimulate production.

Boston's Mayor Welcomes Foundrymen

Immediately following Mayor Curley's address, adjournment was taken to Paul Revere hall where the opening joint session of the American Foundrymen's association and the American Institute of Metals was held. The meeting was called to order by J. P. Pero, retiring president of the American Foundrymen's association. He reintroduced Mayor Curley, who extended his remarks begun in the Grand Hall at the flag raising ceremony. "Nearly every city and village in the land," he said, "has its soldiers' monument, but what we need is more monuments to peace enforced by a free people and to the constructive achievements of peace."

"A convention such as this now being held in Boston," he continued. "is a great monument to constructive effort, and it is gratifying that such a meeting should be held in New England, the cradle of American liberty, in the midst of the greatest war ever waged. It augurs well for the future."

The response to the address of welcome was delivered by R. A. Bull, past president of the American Foundrymen's association and general manager of the Duquesne Steel Foundry Co., Pittsburgh.

J. P. Pero, superintendent, Missouri Malleable Iron Co., East St. Louis, Ill., retiring president of the American Foundrymen's association, delivered his annual address immediately after Mr. Bull's response. It traced the progress of the association during the past year and outlined some of the problems foundrymen must solve in the immediate future. The salient features of the address are quoted below:

"I am sure you will pardon my pride as a New Englander in presiding over this convention in the principal city of New England,—Boston—the Hub of the Universe. Previous to this meeting, we have held but one convention in New England, at Boston, in 1902, 15 years ago. As a matter of history, perhaps not generally known particularly by some of our younger members, let me remind you that 15 years before the Boston convention, and nine years before the first convention of the A. F. A., the New England Foundry Foremen's association was organized in Springfield, Mass., in 1887.

"That, so far as I have been able to learn, was the first association of this kind ever organized. It included in its membership the leading foundry foremen of that period in New England, some of whom are here today, while others are represented by their descendants. It was my good fortune to conceive the idea of such an association, perform the preliminary work for the first meeting and preside at the opening session of this first association organized for the interchange of views and experiences in foundry practice, and for the general uplift of the foundry trade.

New Officers

American Foundrymen's Association

President
Benjamin D. Fuller
Westinghouse Electric & Mfg. Co.,
Cleveland

Vice President
Stanley G. Flagg III
Stanley G. Flagg & Co.,
Philadelphia

Secretary-Treasurer
A. O. Backert
The Penton Publishing Co.
Cleveland

"As foundrymen, we point with pride to the wonderful progress made in foundry practice in the past 25 years, and as members of the A. F. A. we are justly proud of the prominent part our society has played in contributing to the present state of development. We have accomplished much, but we have only begun. I believe we have reached only the threshold of progress. The door is open for still greater improvement, and I predict that those of you who attend our session 25 years hence, will marvel at the gigantic strides made during that period, even as now in retrospect we wonder at the progress already made.

"In these enlightened times the questions of the health, safety and comfort of employes are receiving much consideration, both from humanitarian and commercial standpoints. Also foundrymen, in common with leaders in every industry, have awakened to the realization of the enormous and unnecessary losses caused by fire.

"One of the supposedly important features of progress during the past 25 years in the foundry, as well as in other industries, is known as specialization; but specialization, like many other seemingly good things has its limitations, and we are at last beginning to realize that specialists are not thorough mechanics. As a consequence, we now face a problem of the utmost importance. It matters not to us, whether the present condition has been brought upon us by the desire of the employer for increased production, or decreased cost, or both, or whether the attitude of the labor unions in restricting the number of apprentices is responsible for existing conditions. We do know that unless steps are taken to make the foundry industry more attractive to our young men, and an efficient system of training and indenturing of our apprentices is adopted, we will have very few capable all-around molders in the next generation.

"Much is being written and said at this time of war profits. I cannot conceive of the possibility of abnormal profits under present conditions of increased cost of materials and labor. There may have been large war profits distributed among a few before the United States went into the war; there certainly were many losses, too, during that period. But I have so strong a faith in the loyalty and patriotism of American foundrymen that I have no hesitancy in affirming that they are above taking advantage of our country's needs and that their chief desire is to see an honorable and lasting peace restored to a world undergoing the throes of a cataclysm such as never before has been known in history.

In the rehabilitation of Europe we are destined to play an important part, and in my judgment the problems we now face in the conduct of this war are but preparation for greater problems in the future. We may rest assured that the American skill and energy will successfully cope with any condition which may arise."

Address of Jesse L. Jones

The annual address of Jesse L. Jones, Westinghouse Electric & Mfg. Co., Pittsburgh, president of the American Institute of Metals, was delivered immediately after the address of Mr. Pero. In his remarks, portions of which are presented on the following pages in the report of the proceedings of the American Institute of Metals, he traced the progress of the nonferrous metal industry under the past year of war conditions, referring especially to the development of the commercial production of electrolytic zinc and to other technical advances.

The reports of the board of directors and secretary-treasurer of the American Foundrymen's association were read in abstract by A. O. Backert, secretary.

The report of the board of directors contains copies of correspondence between government officials and the officers of the association regarding a proposal to send a representative committee of foundrymen abroad to study the manufacture of shells and grenades in French foundries. This suggestion was not acted on favorably at Washington. Copies of correspondence with the secretary of war regarding an exhibit of war materials at Boston and with the President pledging the services of the association for the vigorous prosecution of the war also are included in this report. In addition, the details of the association's business activities during the past year are given in full.

The leading features of the report of the secretary-treasurer are as follows:

"It is gratifying to report that during the fiscal year, ending June 30, 1917, the membership of your association passed the 1000-mark and on that date the enrollment attained a total of 1017. In the 12-month period from July 1, 1916, to June 30, 1917, 147 foundrymen were admitted to membership, of which 124 were active and 23 associate. The resignations aggregated 48, and 49 members were dropped for non-payment of dues. While the total book membership was 1017 on June 30, the total paid enrollment on this date was 970, as compared with 918 the previous year. Therefore, the actual paid membership showed a gain for the year of 52 or 5.5 per cent. The associate membership on June 30, this year, was 124, against 150 a year ago, a decline of 26. This apparent lack of interest in the affairs of your association by those entitled to this associate privilege is to be deplored and it is suggested that the active members endeavor to enlist the interest of their superintendents and foremen in the activities of this body. Ever since the Associated Foundry Foremen were merged with this association, the associate membership has steadily declined. It is possible that these members feel that the material benefits derived from such affiliation is not in proportion to the expenditure and it is suggested that a reduction in the price of *The Transactions* be made to associate members who desire to retain the record of our annual meetings in permanent form. Although several successful campaigns for membership have been conducted during the year, nevertheless the aid and support of the members is urged in enlisting the interest of foundrymen generally in the work of our society.

Board of Directors

American Foundrymen's Association, 1917-1918

H. R. Atwater, Osborn Mfg. Co., Cleveland.
R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh.
Henry A. Carpenter, General Fire Extinguisher Co., Providence, R. I.
H. E. Diller, General Electric Co., Erie, Pa.
Stanley G. Flagg III, Stanley G. Flagg & Co., Philadelphia.
Benjamin D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.
Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tennessee.
C. E. Hoyt, Chicago.
W. A. Janssen, Canadian Steel Foundries, Ltd., Montreal, Que.
S. T. Johnston, S. Obermayer Co., Chicago.
J. F. Kent, American Cast Iron Pipe Co., Birmingham.
V. E. Minich, Sand Mixing Machine Co., New York.
J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.
Maj. Joseph T. Speer, Pittsburgh Valve Foundry & Construction Co., Pittsburgh.
H. B. Swan, Cadillac Motor Car Co., Detroit.
A. O. Backert, Penton Publishing Co., Cleveland.

"The expense involved in conducting the affairs of your association has increased steadily and while the treasury showed a balance at the end of the fiscal year, nevertheless it might be necessary to increase the dues slightly to cover the added cost of operation. Several technical societies have been compelled to take this step, and while it is not urged for immediate consideration, nevertheless, constantly mounting costs may compel this action within a year to provide sufficient revenue to conduct the affairs of the association. The board of directors authorized the employment of an assistant to the secretary at a salary of $50 per month. He is serving largely in an editorial capacity and has greatly reduced the burden of the secretarial office.

"Increased operating expenses were more than balanced by the enhanced revenue, the receipts having exceeded the disbursements by $391.13 and the cash on deposit June 30, 1917, was $594.85, as compared with $203.72 the previous year. The total receipts were $16,582.60, of which $1000 were transferred from the profits of the Cleveland exhibition and $337.11 were set aside as a research fund to be drawn upon for special investigations to be authorized by the board of directors. This fund was established by the local committee in charge of the entertainment and reception of the foundrymen at Cleveland last year and represented the balance in the local fund after all expenses were paid. Thus far it has not been drawn upon and it is hoped that it may be increased materially before special work is authorized. The inventory of supplies, furniture and fixtures, emblems, unpaid balance due on the exhibition account and the balance of the American Foundrymen's cost work account aggregated $1,932.07. The disbursements were $16,191.47, the receipts having exceeded the expenditures by $391.13.

"At Cleveland last year your association undertook, for the first time, the management of the exhibition of foundry supplies and equipment and machine tools and accessories. The success of this venture is reflected by a balance of $6829.60 after the payment of all expenses. The total recipts were $27,127.93 and the expenditures $20,298.33. To the exhibitors was made a refund of 10 per cent of the cost of their space, $1000 was paid to the technical department and $166.50 to the American Institute of Metals. After all of these payments a comfortable balance remained, which was sufficient to assure the success of the Boston show without the financial assistance of the technical branch. In this connection the members of this organization may point with pride to the success attained in financing the big undertaking. No money was borrowed, nor was the technical fund drawn upon to defray any of the expense. The Cleveland exhibition financed itself and the surplus was sufficient to guarantee the payment of all obligations that would be incurred in the preliminary work preceding the Boston show."

A paper entitled "Fire Protection in Industrial Plants," by C. W. Johnson, Westinghouse Electric & Mfg. Co., East Pittsburgh, was read by title. This paper, which was contributed to the joint program by the American Institute of Metals, was accompanied by written discussions by F. O. Clements, Dayton Research Laboratories Co., Dayton, O., and Francis P. Sinn, New Jersey Zinc Co., Palmerton, Pa. Portions of Mr. Johnson's paper are as follows:

"The danger of fire is always present. It can be likened to a crafty, sleepless enemy, constantly watching and waiting for an indication of weakness in our defense so that it may strike when and where we expect it least. In considering the subject of fire protection it is necessary that we always look upon it in this light. There is no such thing as planning and arranging for certain protection and then going about our other business and forgetting the danger of fire. It is only by "eternal vigilance" that fires can be avoided, and it is only by the most complete preparedness that they can be promptly extinguished. "The whole theory of fire protection is expressed in the preceding paragraph; the trouble with us is that we are not sufficiently impressed with what it means. In many plants of small size there are frequently times when weeks, or even months may pass without a small fire, and vigilance and precautions accordingly lapse. In extremely large plants, comparatively small fires occur from time to time, and for that reason it is more easy to retain the necessary alertness. However, even under such conditions, after the repeated experience of having these small fires quickly extinguished, the majority of the responsible heads in the plant are apt to assume, as a matter of course, that those whose special business it is will always attend to their duty and prevent any serious conflagration. In this way a still greater menace is introduced in the carelessness which the factory heads develop with regard to the danger of fires. It therefore becomes necessary that there be some positive, driving force, ever present, to constantly, and at all times, hammer in the essentials of vigilance and preparedness.

"The subject of fire protection may be subdivided into: First, the elimination of the causes of fires; second, the protection against the spreading of fires when once started; and, third, the extinguishing of fires.

An impressive fact surrounding the causes of fires is that in almost every case they are caused by negligence and carelessness of the most obvious kind, and that they can be prevented by observing the most simple expedients and watchfulness. If we can but realize the truth of this statement and take it to heart properly, we will have taken the first step toward fire prevention. But someone must do this and do it every day; and do it intelligently—not merely as a matter of form—and if the person is absent whose duty it is to attend to such things, then there must be some positive plan by which someone else will be present and will do the things that must be done. This is an attempt at saying what is meant by "eternal vigilance."

"To sum up the matter: We must do all we can not to let fires start. If they do start, we must have positive arrangements so that the fact will be known and announced at once. When this fact is announced, trained men with proper equipment must be gotten to the scene without loss of time, no matter whether the fire occurs at four o'clock Sunday morning, or during working hours, when all the employes are available for assistance."

Nominating Committee

The nominating committee, appointed at the Monday session, included R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh, chairman; A. W. Walker, Walker & Pratt Mfg. Co., Boston; W. H. McFadden, past president, American Foundrymen's association, Ponca City, Okla.; Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn.; Arthur T. Waterfall, Dodge Mfg. Co., Detroit; S. T. Johnston, S. Obermayer Co., Chicago; A. B. Root Jr., Hunt-Spiller Mfg. Corp., Boston; and Stanley G. Flagg Jr., Stanley G. Flagg & Co., Philadelphia.

The resolutions committee, also appointed at the Monday session, was as follows: Henry A. Carpenter, General Fire Extinguisher Co., Providence, R. I., chairman; R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh; Dr. Richard Moldenke, Watchung, N. J.; J. F. Kent, American Cast Iron Pipe Co., Birmingham, Ala.; Stanley G. Flagg III, Stanley G. Flagg & Co., Philadelphia; R. F. Harrington, Hunt-Spiller Mfg. Corp., Boston; and B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland.

Tuesday Morning Session

The Tuesday morning session devoted to general topics was opened at 10:30 a. m. in Paul Revere hall, J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill., presiding. The papers presented and the discussion which they prompted dealt principally with the problems of co-operation between the engineering and manufacturing branches of the foundry industry and with the proper training of young men for positions of responsibility as foundrymen.

H. R. Atwater, Osborn Mfg. Co., Cleveland, in a paper entitled "The Foundry from the Viewpoint of the Sales Engineer", advocated better co-ordination of the work of the various foundry departments. Mr. Atwater first touched upon the labor problem, emphasizing the fact that labor is constantly demanding a larger share of the profits of the foundry industry. In commenting upon the attitude of foundry workmen, he said:

"It is generally stated as a fact that molders do not take kindly to molding machines, or in fact to the use of any other modern device that may be placed in the foundry. In many plants this has been demonstrated to be true, although the writer knows of plants where union molders in good standing work on molding machines and turn out a production in some cases 1000 per cent greater than was done when the work was made by hand. Moreover, the wage earned is more than double any union scale in the country.

"In stating this fact, it is not intended to open up a discsussion as to which is the better method—that of trying to work molders on machines or breaking in laboreres to operate them—but rather to bring up the question to the foundry industry and to ask if we are looking far enough ahead with a large enough vision to meet the requirements. Are we taking the opportunity to organize our plants and to equip them so that their production will not be cut down? This is the important thing whether we are operating with molders or so-called handy men. In these days when men are so scarce and the need of increased production is great proper means must be found to work both molders and handy men to their capacity.

The Engineer and the Foundry

"It is the writer's opinion that the success or failure of modern equipment and particularly molding machines in any given plant depends on the state of mind. Unless complete co-operation is given from the head of the plant down through the superintendent, foreman, patternmaker or others in charge, no very considerable success will be obtained from either the working of molders on the machines or the use of laborers. The thought and co-operation necessary to make a success must be such as to make a careful analysis of the cost of production on given patterns, an understanding of the proper rigging of the patterns and the kind of flasks to be used, and the price basis established on a quantity production that will largely increase the wage of the operator as well as bring a largely increased production to the plant. It is not possible to get a largely increased production unless the operators are to share in this increase."

Mr. Atwater also advocated the interchange of ideas on foundry operation and management as a means of promulgating the principles of better foundry practice. In conclusion he states that the hope of the industry in the future depends on the installation of power equipment and the training of laborers to successfully operate it.

F. J. McGrail, Struthers-Wells Co., Warren, Pa., read a paper on "The Relationship of the Engineering Department to the Pattern Shop and Foundry". Mr. McGrail's paper states that in some places ideal teamwork exists in foundry departments, but "it is a lamentable fact and a sad commentary on some of our industrial plants, that co-operation is conspicious by its absence. Many departments are continually working at cross purposes, when, if a closer relationship existed, costly errors in design and improper methods employed in the construction of patterns and core boxes might be eliminated."

Mr. McGrail laid special emphasis upon the evils of misunderstandings between the executives of the departments of a foundry. He also defined co-operation and pointed out how it can best be applied to the average foundry organization.

Mr. McGrail's paper continues in part as follows:

Need of Consultation

"If the writer were asked to name the one qualification most needed in the engineering service, he should unhesitatingly say: 'Consultation and planning with other executives.' Innumerable instances might be given where financial loss might have been averted if a little planning were done. One case may be cited as an example of bad practice, due to a lack of consultation and co-operation.

"The man in charge of the pattern shop and his associate in the foundry department are chiefly concerned with their labor costs, but this does not necessarily imply that a low labor cost of production in the pattern shop means an economical cost of production in the foundry. The methods employed in the construction of patterns and core-boxes to suit the equipment in the foundry, or other changes which might be easily made to facilitate a more rapid output of castings, are important factors in determining economy. If a slight increase in the cost of a pattern will largely decrease the cost of molding and coremaking, it is safe to assume that the extra outlay is warranted, as it contributes much towards a better feeling between the two departments.

"Unfortuntely, one does not learn very much about anything in a lifetime, but if one would practice honest, persistent co-operation, it would be realized that one can frequently 'light his candle by the other fellow's flame', and if the work in the engineering department is brought to a successful and profitable conclusion, there is 'glory enough for all'."

Art Versus Science

Mr. McGrail's paper prompted an exceedingly interesting discussion of the ever present problem of the relation between engineers and the operating executives of foundries. Stanley G. Flagg Jr., Stanley G. Flagg & Co., Philadelphia, suggested that students of the problem sometimes lose sight of the difference between art and science as applied to the foundry. The foundryman is versed in the art of the industry, while the engineer deals with its scientific phases. Mr. Flagg won the emphatic approval of many of his listeners when he stated that much of the progress in the foundry industry has been due to engineers who have continually urged foundrymen to do the "impossible". Though the credit is due the engineer, the burden has fallen upon the foundrymen, who have transformed the theory of the engineer to practical achievement.

J. W. Langston, G. & C. Hoskins, Ltd., Sydney, Australia, touched upon the Australian system of training foundry apprentices, showing that co-ordinated studies in the engineering and manufacturing branches give the Australian young men a blended knowledge and appreciation of the theory and practice of foundry management. For this reason, explained Mr. Langston, there are no grounds for controversy between the engineering and operating departments in Australian foundries. Mr. Langston paid a high tribute to the American engineers, saying that they have given the foundrymen the machines and equipment which have paved the way to the present high standing of America in the foundry industry.

Engineers First in Europe

J. P. Pero, chairman of the meeting, then summarized the situation, outlining what the engineers and the foundrymen have achieved, even though working at cross purposes. He referred to the evils resulting from the too prevalent practice of pitting one department against the other, especially in the matter of keeping down costs. Following Mr. Pero's remarks, a speaker called attention to instances in which the pattern shop is unjustly blamed for difficulties which properly should be charged to lack of co-operation on the part of the foundry. Richard Moldenke, Watchung, N. J., compared the management of foundries in Europe with those in the United States. In the latter country, most of the foundrymen are self-made men who have risen from the ranks by virtue of their experience and whose technical training has been acquired as an adjunct to the business of making castings. In Europe, and in Australia as well, the foundries are managed by trained engineers who were engineers first and practical foundrymen second.

Dr. Moldenke submitted the report of the advisory committee to the United States bureau of standards. The report shows that during the past year, at the request of Director Stratton of the bureau of standards, 25 samples of sandblast sand were collected from various manufacturers for the purpose of testing them with a view to standardization. Micrographs of the sand and the results of the tests are presented in the report, which will be published in an early issue of THE FOUNDRY.

By unanimous vote the report was accepted and the committee instructed to continue its work of co-operation with the bureau of standards.

Dr. Moldenke submitted the report of the A. F. A. representative on the joint committee for the classification of technical literature. This report includes a suggested classification of foundry literature in which the various topics are grouped under the following headings: The foundry, generalia, the layout of the shop, equipment, raw materials, molding processes, melting processes, pouring methods, finishing processes, laboratory and testing methods, and the castings. Each of these general classifications are subdivided to include practically every item of foundry literature. The report was unanimously accepted and the representative was discharged.

FATHER AND DAUGHTER

J. P. Pero, retiring president of the A. F. A., with his daughter, May Rosalind Pero, soloist at the annual banquet, Sept. 27

W. B. Hunter, Fitchburg high school, Fitchburg, Mass., talked interestingly of the advantages of co-operative shop training. He outlined the course of study adopted at Fitchburg, whereby the student pursues his studies in the class room for one week and then is given training in the shop for a week, this routine being repeated every two weeks. Mr. Hunter pointed out that this system doubles the capacity of both the school and the shop. The boy who receives this kind of training is three years ahead of the boy who first completes his high school course and then devotes a number of years to the shop.

John Ritchie Jr., Massachusetts Institute of Technology, Boston, read a paper on "Facilities for Technical Training at Massachusetts Institute of Technology". Mr. Ritchie described the recent improvements at the institute and outlined the methods of conducting the engineering courses.

"Efficiency in the Foundry", a paper written by James A. Fitzgerald, Reno, Pa., was read by title.

Elect Directors for 1917-18

Benjamin D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland, presided at the Wednesday session on foundry costs and general topics. Sixteen members of the association, previously nominated by the nominating committee, were elected directors to serve for the year 1917-18. The names of the directors elected appear on page 413.

J. F. Kent, American Cast Iron Pipe Co., Birmingham, Ala., read a paper on "Improving the Relationship Between Employer and Employe". Mr. Kent's paper shows what has been done in a southern pipe foundry to promote a better feeling between the employers and workmen, and deals especially with the troublesome problem of handling negro labor. It also outlines the results obtained in the effort to promote cleanliness among workmen and explains how the negro employes were gradually brought to a full appreciation of the benefits of the medical department established by the company. This paper also describes the activities of the Y. M. C. A. and presents figures to show the attendance at educational classes, entertainment, athletic games, etc., arranged for the workmen. The attitude of the employer toward the welfare movement is summed up in the sentence "We believe implicitly that a man expects and has a right to expect, something more than that which he gets in his pay envelope, and that is what we are trying to give him."

Administering Welfare Work

R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh, spoke of the danger of antagonizing workmen by adopting a paternalistic attitude. Welfare work must be administered unostentatiously to be effective. Another speaker referred to the benefits of "dry" legislation in the state of Alabama, stating that in Birmingham, which has a population of 190,000, the average number of persons in the city jail has dropped to 26 since the saloons were wiped out.

William Judson Kibby, Cleveland, presented a paper entitled "How Character Analysis Solves the Man Problem", parts of which follow:

"King Solomon said, 'As a man thinketh in his heart, so is he.' And may we add, that that which a man thinks in his heart, writes itself upon his face. Our thoughts do write themselves upon our faces. They are indelible and express themselves in little physical manifestations so that

Resolutions Adopted at Boston Convention

War Service Board

WHEREAS, the foundrymen of America represented in the annual convention now assembled of the American Foundrymen's association have a strong conviction that the government of the United States can and should receive at the hands of those engaged in the foundry industry in this country, more effective assistance than has hitherto been rendered by foundrymen in the successful prosecution of the war; and

Whereas, the American Foundrymen's association, a national organization of foundrymen engaged in the production of castings which has a purpose purely technical and educational, has in hand or can obtain from its membership, funds thought to be necessary for the purpose mentioned herein; therefore

Be it resolved that the American Foundrymen's association does hereby authorize and direct its president to appoint a War Service Board to consist of five of the ablest men engaged in the manufacture of gray iron, malleable iron, steel and nonferrous castings in the United States irrespective of their membership in any organization, who shall serve without compensation and shall give such assistance as a board operating directly, or as a central board governing subsidiary boards or committees, to the government of the United States, as may be possible with the approval of said government, in the securing of castings of proper quality, at desired rates of production, at fair prices, to meet the needs of said government; and in the conducting of any investigations into the manufacture of castings considered advisable in the furtherance of the objects mentioned herein; and

Be it further resolved that the proper officers of the American Foundrymen's association are hereby authorized, if considered advisable by the said War Service Board which shall be appointed with the approval of the United States government, to disburse such sums as may be necessary to defray the proper expenses for conducting the work of the co-operation with the United States government referred to in the foregoing; and

Be it further resolved that the directors of the American Foundrymen's association be and they are hereby authorized to take such steps as they may consider advisable to appropriate or secure whatever funds may be needed for the most effective co-operation proposed in these resolutions.

Declaration of American Foundrymen's Association

IMMEDIATELY following the declaration of war, your board of directors, by unanimous vote, adopted a resolution extending to the government the support of the foundrymen of America, which was transmitted to the President and received acknowledgment from the nation's executive office. This action was taken because of the impossibility of securing a prompt expression of opinion from our large body of members and because your board was certain that its action expressed the undivided sentiments of every casting manufacturer in the United States.

This association, now in annual convention assembled, not only ratifies the action of the board of directors in the adoption of this resolution, but again pledges every resource of the foundrymen of America to the government in the successful prosecution of the war in order that it may be brought to an early termination.

Therefore we the members of the American Foundrymen's association, representing the great steel, gray and malleable iron industries of the United States, will do all within our power to mobolize our plants and their output, placing them at the disposal of the government and will speed-up production to the end that the needs of our government will be more promptly met and in every other way we promise our aid and support to our country to hasten the defeat of our enemies.

Liberty Loan

WHEREAS, the members of the American Foundrymen's association realize that for the prosecution of the war large sums of money are needed, making necessary the sale of government bonds in addition to the sums raised by taxation, and whereas another issue of Liberty bonds is about to be made, therefore

Be it resolved, that the members of the American Foundrymen's association devote the same efforts to the sale of the second and succeeding issues as they so patriotically devoted to the first bond issue, and

Be it further resolved, that the employing members of this association render every possible assistance to their employes in the purchase of bonds.

Resolution of Thanks

WHEREAS, this convention of the American Foundrymen's association is one of the most successful in its history, and

Whereas, this is attributable in a very great measure to those who have toiled unceasingly in the reception and entertainment of the large number of visitors in attendance, and

Whereas, the technical program was unparalleled in number and excellence of papers on a variety of subjects of interest to gray and malleable iron and steel foundrymen, therefore

Be it resolved, that the members of the American Foundrymen's association extend their appreciation and hearty thanks to the New England Foundrymen's association and the members of the committees of that organization who have made our visit to Boston so enjoyable and whose hospitality was without bounds; to the City of Boston and its chief executive, Hon. James M. Curley; to the Chamber of Commerce; to the management of Mechanics building; to the authors who contributed to our program; to the exhibitors who made our show a success; to the daily press of Boston, the trade press of the country, the hotels, etc., to all who in any way contributed to the wonderful success of this, the twenty-second annual meeting of our organization.

those who are thinking honest, agreeable, generous, kindly thoughts have that kind of face. Those who are thinking dishonest, selfish, greedy thoughts, have dishonest, selfish, greedy faces. Those who are timid and cautious, have timid, cautious ways and faces. Those who have great physical energy, driving force, express such thoughts; and those who are cunning and foxy, have cunning, foxy faces.

Need of Character Analysis

"The question was asked of one of America's greatest executives as to what he thought was the greatest weakness of the coming executive, and he, after careful thought, came back with this answer: 'The lack of analysis.' The average individual cares little or nothing about analyzing and finding the whys and wherefores of the things he seeks to accomplish. In other words, he will not seek to find the units of the analysis; or after having found them, to carefully weigh each one; or after having weighed each unit, to place it back into the whole, thus getting a clear picture of the idea or thing from a wholly disinterested or unprejudiced standpoint. The age in which we live demands that individuals in pivotal positions, which call for opinions and judgments based upon fact, be analysts; and no one of ordinary intelligence will doubt this assertion."

Mr. Kibby emphasized some of the principles of character analysis by referring to charts showing the characteristics of various types of individuals. He also demonstrated the application of these principles by analyzing W. H. McFadden, past president of the American Foundrymen's association in a manner which excited favorable comment.

Victor T. Noonan, director of safety, industrial commission of the state of Ohio and chairman of the American Foundrymen's association committee on safety, sanitation and fire prevention was not present. Therefore the report of the committee was submitted by Richard Moldenke, Watchung, N. J. The letter of transmittal, accompanying the proposed safety and sanitation code, refers to the negative results of the conference held at Buffalo, July 30, and outlines the basis of agreement suggested by Magnus W. Alexander, General Electric Co., West Lynn, Mass. These suggestions, which were considered by the A. F. A. safety committee at an adjourned meeting in Buffalo Aug. 17, were not approved. Instead, the committee decided to ask the association to adopt the proposed code as finally revised by the A. F. A. representatives.

After reading the letter of transmittal, Dr. Moldenke moved that the association adopt the code as proposed. W. H. Barr, president National Founders' association; C. L. Newcomb, Dean Steam Pump Co., Holyoke, Mass.; Stephen E. French, Athol Machine Co., Athol, Mass.; G. P. Aborn, Blake & Knowles Steam Pump Works, East Cambridge, Mass.; and others spoke against the adoption of the code. With Mr. Moldenke's permission, the original motion was withdrawn and Mr. Aborn moved to refer the report on the safety code back to the committee for further conference with representatives of the National Founders' association. This motion provided that the revised code again be submitted to the association at the next convention. This proposal was discussed by Messrs. Barr, Newcomb, French and Aborn, Dr. Moldenke, R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh; J. P. Pero, Missouri Malleable Iron Co., East St. Louis, Ill.; A. O. Backert, Penton Publishing Co., Cleveland; Thomas J. Soults, Sill Stove Works, Rochester, N. Y.; W. E. Freeland, *The Iron Age*, Worcester, Mass.; W. H. McFadden, Ponca Oil Co., Ponca City, Okla., and others. When put to a vote, the motion was lost.

Paul Revere

NEVER did the American Foundrymen's association assemble amid more appropriate surroundings than at the twenty-second annual meeting in Boston during the week of Sept. 24. Beautiful Paul Revere hall in the Mechanics' building was set aside for the major sessions. Architecturally effective and suggestive of the patriotism of New England's great pioneer foundryman, this beautiful meeting room harmonized perfectly with the week's proceedings. Inspiration was found in the mere setting of the convention.

R. A. Bull then moved that the chairman, Benjamin D. Fuller, appoint a committee to go over the report on the safety code and hear the criticisms of those opposed to its adoption. This motion was passed.

Standard Cost System

In spite of high prices and wide margins of profit, it was evident from the interest displayed in the report of the cost committee that the importance of this vital subject is more widely appreciated now than ever before. The committee's report, which was presented by Benjamin D. Fuller, chairman, Westinghouse Electric & Mfg. Co., Cleveland, outlines the progress made during the past year in developing a standard cost system for the American Foundrymen's association. For the first time a definite plan has been evolved and tangible results achieved. An outline of the plan is given in the committee's report, which is in part as follows:

At the annual meeting of your association held at Atlantic City in 1915, the suggestion was made that the members of this organization raise a fund to promote the installation of a standard cost system in the casting plants of its members. The cost committee was instructed to make an investigation and devise a plan for carrying on this work. At the meeting in Cleveland last year progress was reported, but definite action was deferred inasmuch as it was believed by the members of the committee it would be exceedingly difficult to enlist the interest of foundrymen in cost-keeping methods during a period of such great industrial activity. However, preliminary investigations proved the feasibility of the plan tentatively devised and immediately following last year's meeting it was decided by this committee to formulate a definite plan of procedure and to undertake the financing of the special cost fund to defray the expense not only of preparing the standard cost system, but to install it in the plants of the members who subscribe to this fund.

Foundrymen Favor Cost System

Inasmuch as the American Foundrymen's association is without adequate means to carry on such special work, it was decided to limit the benefits of the standard cost system to those members of the association, and only those, who subscribe to this fund on the basis of the number of molders and coremakers employed. This productive labor, it was believed, furnished the best index to the capacities of the plants to be interested and the cost of carrying on this work was estimated on the average number of molders and coremakers employed. It was believed that if a fund of from $8000 to $10,000 were subscribed the success of the undertaking would be assured. Estimating the possibility of an initial 100 subscribers for a total of from $8000 to $10,000, it was decided to adopt the following schedule of charges: Foundries employing up to 40 molders and coremakers, $50; foundries employing from 40 to 200 molders and coremakers, $1.25 for each molder and coremaker employed; and foundries employing more than 200 molders and coremakers, $250.

It is gratifying to be able to report a total of 102 subscriptions amounting to $7246.25, and cash payments already received from these subscribers, representing 25 per cent of their total subscriptions, aggregate $1950.68.

Two meetings of the cost committee were held during the year, principally for the purpose of considering a plan of operation and to select a cost accounting firm to carry on this work. Propositions were presented by C. E. Knoeppel & Co., New York, and Scovell, Wellington & Co., Boston. At a meeting held at Cleveland, Friday, Feb. 16, 1917, no definite decision was reached and it was concluded to extend an invitation to representatives of both of these concerns of cost accountants to explain in detail their respective propositions. On Monday, Feb. 26, a meeting was held at the William Penn hotel, Pittsburgh, which was attended by B. D. Fuller, Westinghouse Electric & Mfg. Co., Cleveland, chairman; J. Roy Tanner, Pittsburgh Valve Foundry & Construction Co., Pittsburgh; H. J. Koch, Fort Pitt Steel Casting Co., McKeesport, Pa.; C. R. Messinger, Sivyer Casting Co., Milwaukee, and A. O. Backert, Cleveland. C. E. Knoeppel of the firm of C. E. Knoeppel & Co., was accompanied by W. A. McCall, a member of this firm, and C. H. Scovell represented the firm of Scovell, Wellington & Co. The representatives of both companies were afforded ample opportunity to present their propositions in detail. After considerable discussion, a letter ballot showed a majority in favor of awarding the contract to C. E. Knoeppel & Co., New York. Authority was obtained from your board of directors to enter into this contract and C. E. Knoeppel & Co., New York, were employed for the purpose of carrying on this work.

Industrial Education

In the report of the committee on industrial education prepared by Frank M. Leavitt, chairman, University of Chicago, Chicago, it is stated that it seemed to the committee that the greatest service it could render the association would come from the establishment of two or three experimental classes of actual apprentices, and in developing a course of study and practice for the apprentices that should have the approval of the employers themselves. The report continues:

"We also felt that such classes should be the result of co-operative action on the part of the employers and the public school system. It was planned, therefore, to have the classes conducted under the auspices of the public schools without expense to the employers or to the association.

All this has taken time and the committee can only report progress. However, some definite steps have been taken. For example, the committee has been assured by the director of vocational work in the Chicago schools that he will establish the courses for which we have asked whenever we will submit the course of instruction and provide the apprentices. The foremen assure us that they will do all in their power to assist in developing the course and in making arrangements to have apprentices take the work.

The report of the A. F. A. representatives on the conference board on training of apprentices, by Frank M. Leavitt, was read by title. A paper by Robert J. Anderson, Cleveland Metal Products Co., Cleveland, entitled "Micro-Metallurgy for the Foundry", also was presented by title.

The gray iron session Thursday morning was opened by the presentation of a note on the characteristics of fine facing molding sands, by C. P. Karr, associate physicist, bureau of standards, Washington, D. C. In reality this paper is a continuation of a report made to the American Foundrymen's association at Cleveland in September, 1916. It refers to the efforts that have been made to find in this country a facing sand to replace fine French molding sand. Results are presented of tests on the fineness, moisture content, specific gravity, melting point and tensile strength of three sands of American origin. The sand most nearly approaching the French sand so far discovered is mined near Zanesville, O.

The report of the A. F. A. committee on general specifications for gray iron castings was presented by title and adopted.

In a paper on "Briquetting Foundry Borings", by A. L. Stillman, General Briquetting Co., New York, the author describes extensive tests made with various mixtures of cast iron for miscellaneous castings and for locomotive cylinders. The physical properties of iron made from mixtures containing briquetted borings are compared with those of iron containing the usual percentages of scrap and pig. Mr. Stillman concludes from the results of the tests that briquettes have a very definite and promising future in foundry practice. He says that briquettes in no way injure the product of the cupola and that their use effects economy. He predicts that the low price of borings in the briquettted form as compared with the cost of heavy iron scrap will encourage the use of briquettes.

A splendid ovation was given Major Edgar Allen Custer, Philadelphia, following the presentation of his paper on "Cast-Iron Shells in Permanent Molds". This paper is published in full elsewhere in this issue of THE FOUNDRY. Major Custer followed the reading of his paper with a few stirring impromptu remarks that aroused the entire audience to prolonged applause. "We must make better castings than ever before," he said. "The best we can do is none too good for our boys in the trenches who we have sent out to fight and win this war for us."

Urges Uses of Cast Iron Shells

The discussion was opened by A. O. Backert, secretary of the American Foundrymen's association, who referred to the reluctance of our ordnance department to adopt cast-iron shells. "Shells of cast iron or semisteel that are so successfully used by both our allies and our enemies ought to be serviceable to us," he declared. "This shell question is all important and must be solved correctly."

In reply to a question, Major Custer said malleable iron is more satisfactory than gray iron for hand grenades because of its superior toughness. Grenades, he pointed out, do not have to be designed to withstand the shock of being fired from a gun. B. D. Fuller referred to tests of cast-iron grenades which he said exploded to powder in a wooden box with walls 1 inch thick, without doing the box any material damage. Malleable-iron grenades, on the other hand, broke into larger pieces that were hurled through the sides of the box. Major Custer explained that ordinary foundry iron usually powders on being exploded; to obtain proper fragmentation a special iron somewhat similar to a wheel iron must be employed.

A paper entitled "Seasoning of Gray Iron Castings" was presented by the author, L. M. Sherwin, Brown & Sharpe Mfg. Co., Providence, R. I. It is published in full elsewhere in this issue.

Other Technical Papers Read

"Modern Centrifugal Cupola Blowers", a paper read by J. A. Shorey, General Electric Co., Schenectady, N. Y., was accompanied by a large number of interesting lantern slides. Other papers read at the Wednesday morning session include: "High Sulphur in Soft Gray Iron", by T. Mauland, Deering Works, International Harvester Co., Chicago; "Factors in the Economical Production of Small Cores in Large Quantities", by R. E. Kennedy, University of Illinois, Urbana, Ill.; and "Experiments to Determine the Most Effective Means of Mixing and Blending Foundry Facing Sands", by R. F. Harrington, Hunt-Spiller Mfg. Corp., Boston.

At the conclusion of the Thursday session, a number of important resolutions bearing on the relations of the foundry industry with the government in the present emergency were presented and unanimously adopted by rising votes. The full texts of these resolutions accompany this report. R. A. Bull announced that, if necessary, the association is prepared to spend $10,000 immediately in behalf of the war service board authorized in one of the resolutions. He also said other sums will be raised as needed. In brief the American Foundrymen's association put itself on record as unreservedly back of the government with all its financial resources and man power.

A paper on "Sand Blasting in the Foundry", by H. L. Wadsworth of the American Foundry Equipment Co., Cleveland, was read by Mr. Alexander of that company. Scarcity of labor and the growth of the safety movement in recent years have greatly stimulated sand-blast practice. Two methods are being pursued, hand and automatic. Both have their ad-

RANDOM SNAP SHOTS DURING CONVENTION WEEK vantages, according to the size and character of the castings. The question of the abrasive is most important. Not enough thought has been given to the selection of the sand. Foundries, he said, are being converted to the use of a hard white sand which does not break up. B. D. Fuller of the Westinghouse Electric & Mfg. Co., Cleveland, said no better investment could be made than the installation of modern sand-blast equipment.

In his paper on "Solution of Foundry Transportation and Conveying Problems," Robert E. Newcomb of the Dean works of the Worthington Pump & Machinery Corp., Holyoke, Mass., described the principal items of equipment for lifting, handling and conveying materials in the foundry.

Wallace T. Montague, Norton Co., Worcester, Mass., described "Factors Contributing to the Econmical Use of Grinding Wheels in the Foundry".

Other papers presented at the Friday session included "Oxy-Acetylene Welding and Cutting", by Stuart Plumley, Davis-Bournonville Co., Boston, and "Refractory Materials Employed in the Metallurgical Industry", by H. C. Arnold, University of Illinois, Urbana, Ill.

A. L. Williston, Wentworth Institute, Boston, addressed the meeting upon the urgent and immediate need of concerted action in training skilled workmen and apprentices for the foundry. A motion prevailed that the executive board of the association be directed to name a committee to make an intensive study of this problem.

It was announced that the conference committee appointed to meet with the National Founders' association to draft a safety code would consist of Earl B. Morgan, Norton Co., Worcester; Ralph H. West, West Steel Casting Co., Cleveland, and the president acting ex-officio. This committee, which previously has been referred to, has not yet completed its work.

Visitors Well Entertained

As was the case of the Cleveland convention last year, the one-session per day arrangement allowed the visiting foundrymen and their friends freedom to enjoy the entertainment features planned by the local committee. On Tuesday afternoon several hundred convention visitors enjoyed a ride on the S. S. ROSE STANDISH in and about Boston harbor. A ball game between the Boston and Cleveland American league teams attracted many fans to Fenway park Wednesday afternoon. That evening members and guests of the allied associations attended a theater party at B. F. Keith's vaudeville house. Thursday a luncheon was held for the visiting ladies and during the afternoon they enjoyed an automobile sightseeing tour to various points of historical interest in Boston and vicinity. Many foundrymen were the guests of the General Electric Co. at West Lynn, where luncheon was served. During the afternoon the men were shown through the various departments of the extensive plant. A large number of foundrymen also visited the stove works of the Walker & Pratt Mfg. Co., Watertown, Mass.

The annual banquet, held Thursday evening in the Copley-Plaza ball room, was attended by nearly 500 members and guests of the allied associations. Alfred E. Howell, Phillips & Buttorff Mfg. Co., Nashville, Tenn., was toastmaster. May Rosalind Pero pleasantly entertained with a number of vocal selections. Judge Moore, New York, gave an after-dinner talk on "Dollars and Sense". John A. Penton, president, Penton Publishing Co., Cleveland, delivered a patriotic address, in which he described the remarkable achievements of France in producing munitions and carrying on the work behind the battle lines. Mr. Penton emphasized the fact that every person in France is pledged to the accomplishment of a single purpose—the winning of the war. In conclusion, he appealed to the men and women of America who remain at home to stand behind those who go to Europe.

Steel Sessions Draw Big Crowds

BECAUSE military experience and practice throws light on the work many foundrymen are undertaking, great interest was manifested in the presentation at the professional session Friday, by Maj. C. M. Wesson, ordnance department, United States army, Watertown arsenal, Watertown, Mass., of his paper, "Steel Castings for Ordnance Construction." In introducing the speaker, President Pero stated he felt confident that American foundrymen working closely with the United States army engineering corps, could master all problems relating to the production of ordnance castings which were possible of solution.

Discussing the paper, Mr. Wilson of the Connecticut Electric Steel Co., New Haven, inquired as to the best treatment of electric steel castings for ordnance. Major Wesson replied he had had no direct experience with making electric steel castings for ordnance, though the Watertown arsenal was about to install a number of such furnaces. Based on what he knew regarding the electric furnace process, however, he believed that since the latter gave a minimum of slag, the required physical qualities for guns could be met with less severe treatment. His experience had shown that in the acid open hearth by holding the metal with the gas off about 10 minutes in the furnace and 5 to 10 minutes in the ladle, the best results could be obtained. Frank Hodson of T. H. Watson & Co., Ltd., Sheffield, Eng., who is in this country introducing the Graves-Etchell electric furnace, stated that in England good steel castings for war use are being made in electric furnaces with basic linings. Castings made for "tanks", he said, showed 90 tons tensile strength, 25 per cent contraction and 20 per cent elongation. Major Wesson told of a test of gun forgings made from basic electric steel after duplexing in the basic open hearth which had shown very favorable results. He thought a splendid opportunity was open to the electric furnace method in filling the numerous orders for large and small guns which were about to be distributed among many companies in America.

R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh, said the attitude of the foundrymen in the past had not been the attitude of the army ordnance experts as to specifications. All this has been changed by the present crisis. Today the steel foundrymen are on the same basis as the army. "All will do their part and will co-operate to the fullest extent to see that the government gets what it wants," he said.

A. H. Jameson, Malleable Iron Fittings Co., Branford, Conn., presided at the Thursday morning steel session. A paper entitled "The Use of Vanadium in Steel Castings" was read by J. Loyd Uhler, Union Steel Casting Co., Pittsburgh. It is stated in this paper that vanadium is not a new discovery, but it is only within the past few years that it has been employed extensively by practical steelmakers. It has the property of combining with both oxygen and nitrogen at high temperatures, therefore eliminating both of these gases from the metal. It also has the effect of causing the carbon to be more uniformly knit together throughout the mass. In conclusion, the author gives the results of interesting tests on vanadium steel castings that were made to take the place of forgings in marine turbines. The castings were made to the following forging specifications. Tensile strength, 67,159 to 78,227 pounds per square inch; elongation in 2 inches, 18 per cent; bending test for 1-inch square bar, 180 degrees over 1½-inch mandrel. The tensile bars were 0.785 inch in diameter.

Mr. Uhler was asked if the titanium employed in these castings was added in the ladle. In reply he stated that it was introduced in the charge, and that the Union Steel Casting Co. prohibits the addition of the element in the ladle. When asked by E. F. Cone *The Iron Age*, New York, if the same practice obtains in the case of manganese additions, Mr. Uhler replied that the manganese is introduced in the ladle in lumps about the size of walnuts.

Describes Small Open-Hearth

An abstract of the paper written by David McLain, McLain's System, Milwaukee, describing a small open-hearth furnace, was read by Mr. Cone:

In the introductory pages of this paper, the author recounts some exceedingly interesting experiences in the early days of the steel foundry business. The operations of William Hainsworth, of Pittsburgh, who established the first bessemer steel foundry in this country, are described in some detail. Throughout his life, Mr. Hainsworth was confident a successful small open-hearth furnace could be built, and he spent thousands of dollars experimenting with apparatus of this character. He never, however, succeeded in realizing his ambition.

The McLain-Carter small open-hearth furnace, which this paper describes in detail, is built in sizes ranging from one to five tons. Oil fuel is used. The oil consumption is stated to be 65 to 70 gallons per ton of steel. The roof, it is claimed, will stand for 500 to 700 heats, with the furnace turning out high-temperature, fluid metal.

Mr. McLain appeared after the abstract of his paper had been read and answered a number of questions regarding the operation of the furnace in question. Anketell Henderson, Commonwealth Steel Co., Sydney, Australia, asked if the melting unit described in the paper is adapted to gas fuel. In reply, Mr. McLain stated that he had experimented with gas while developing the furnace, but that better results had been obtained with oil. He also explained that about 70 gallons of oil are consumed per ton of metal when the furnace is operating on a basis of five 2-ton heats in 12 hours. The fuel, said Mr. McLain, costs from 4¼ to 5¼ cents per gallon. In addition to the oil used while the furnace is in operation, about 100 gallons are consumed during the night to keep the walls hot. Approximately 200 gallons are required for this purpose every 24 hours when the furnace is idle. The conversion cost in a furnace of this type is from $7.50 to $8.50 per ton, including fuel, labor, overhead, depreciation, refractories, etc.

R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh, questioned Mr. McLain as to the minimum section of castings that can be poured from metal produced in this open-hearth furnace. Mr. McLain cited a number of instances in which sections as thin as ⅛ inch had been poured. A Milwaukee foundry company using one of the small open-hearth units is pouring crucible molds and another company is making castings from malleable casting patterns without difficulty. Mr. McLain recommended that metal for castings of light section should be poured in heats not exceeding two tons.

Benjamin D. Fuller

BENJAMIN D. FULLER, recently elected president of the American Foundrymen's association is the ideal type of practical foundry executive. He has risen from the ranks to a high position in the industry through his own efforts unaided by an extensive formal education. He is the son of a Unitarian minister and was born at South Scituale, Cape Cod, Mass., Feb. 10, 1864.

He commenced his foundry career as an apprentice in the Pittsburgh Locomotive Works, now a part of the American Locomotive Co. at Allegheny, Pa., in 1876. After eight years as a boy in this shop he went with the Westinghouse Machine Co., Wilmerding, Pa., as a journeyman molder. In 1885 he was employed by the Fort Pitt Foundry for a year, thus gaining valuable experience in steel foundry practice. He also was for a time employed by the Fuel Gas & Electric Mfg. Co., Pittsburgh, which was later absorbed by the Westinghouse interests. In 1893 he was appointed assistant foreman of the old Allegheny foundry of the Westinghouse Electric & Mfg. Co. He advanced steadily and it 1906 was transferred to the Cleveland plant of the Westinghouse company as general superintendent. This is now one of the largest units in the great Westinghouse organization. Mr. Fuller has been associated with the Westinghouse companies continuously for 27 years.

New Oil-Burning Apparatus

W. A. Janssen, Canadian Steel Foundries, Ltd., Montreal, Que., read a paper describing a new method of burning crude oil.

In reply to a question asked by Frank B. Runser, National Foundry Co., Erie, Pa., Mr. Janssen explained that an elbow and pipe bolted to the lower flange of the vaporizer is all that is required for a burner. The gas, he said, burns with a transparent flame similar to that in a soaking pit in steel practice. The size of the vaporizer, said Mr. Janssen, depends upon the oil consumption per hour.

Mr. Henderson asked if by-product tar can be utilized in the vaporizer, and referred to the possibility of clogging due to carbon deposits on the baffles of the apparatus. Mr. Janssen related the experience of a company which is using coal tar exclusively and also a mixture of coal tar and heavy crude oils. No difficulties due to deposition have been encountered and on several occasions the examination of the baffles has shown no trace of carbon.

Adopt Steel Foundry Standards

The report of the A. F. A. committee on steel foundry standards, dealing with specifications for standard sleeves, special sleeves and graphite ladle stopper heads, was read by Mr. Janssen, chairman of the committee. The complete report appears elsewhere in this issue of THE FOUNDRY.

The proposed standards elicited favorable comment from R. A. Bull, Duquesne Steel Foundry Co., Pittsburgh; C. H. Gale, Pressed Steel Car Co. McKees Rocks, Pa.; and J. Lloyd Uhler, Union Steel Casting Co., Pittsburgh. The report of the committee was unanimously accepted and the proposed standards adopted.

R. A. Bull read a paper entitled "Molding and Casting Large Slag Pots", written by C. J. McMahon, Illinois Steel Co., Chicago. An article describing the methods employed in molding these large slag pots will appear in an early issue of THE FOUNDRY.

Considerable interest was shown in the presentation and discussion of papers dealing with electric furnace design and operation. W. A. Janssen, Canadian Steel Foundries, Ltd., Montreal, Que., presided. C. R. Messinger, Sivyer Steel Casting Co., Milwaukee, read a paper comparing the electric furnace and steel converter in the manufacture of small steel castings.

Ralph H. West, West Steel Casting Co., Cleveland, called attention to the short life of several furnace roofs mentioned in Mr. Messinger's paper. He pointed out that whereas some of the roofs had given service for more than 400 heats, three had failed before 10 heats had been tapped. Mr. Messinger attributed this apparent inconsistency to the fact that the short-lived roofs were in service during the time when new melters were learning how to operate the furnace. The fault, he thought, was not due to the failure of engineers to specify satisfactory roofs, but to the inexperience of the melters.

W. R. Bean, Naugatuck Malleable Iron Co., Naugatuck, Conn., asked Mr. Messinger to name the principal factors which make 24-hour operation of electric furnaces desirable. In reply, Mr. Messinger stated that continuous operation enables the manufacturer to obtain a low power rate from the central station company, reduces the consumption of refractories, and greatly increases the output of the plant. Anketell Henderson, Commonwealth Steel Co., Sydney, Australia, asked if the water-cooled electrode has proved dangerous. Mr. Messinger replied that in his experience two accidents had occurred, each of which caused injuries to the workmen. He stated that the trouble was caused by burning the bottoms down until steam was generated in the cooling chambers, resulting in violent explosions. These failures, according to Mr. Messinger, should not condemn the furnace, as the accidents were obviously caused by carelessness. Several speakers discussed the problem of electrical surging in the power lines, and it was generally agreed that a central station company can profitably serve only a limited number of manufacturers who operate single-phase furnaces of large capacity. The load on the power plant must be well balanced to assure good servie to power consumers.

Carl H. Booth, Booth-Hall Co., Chicago, read a paper written by Douglas Walker of the same company dealing with recent developments in the application of the electric furnace to the melting problem.

The paper, "Notes on an Electric Furnace Design," by John A. Crowley, John A. Crowley Co., Detroit, was read by A. M. Minnick of the same company.

P. A. E. Armstrong, Ludlum Steel Co., Watervliet, N. Y., stated that the arrangement of the electrodes, their holders, the busbars and flexible cable, has an important bearing upon the efficiency of the furnace. He spoke of difficulties encountered because of sticking and broken electrodes. The trunnion tilting arrangement is unsuited to large furnaces, declared Mr. Armstrong, because it causes the spout to move in such a large arc that the ladle has to be moved toward the furnace to prevent spilling the metal near the end of the tap. He recommended the rocker arm as the best tilting arrangement for large furnaces. Referring to the flow of current through the hearth, Mr. Armstrong claimed that the magnesite bottom must attain a temperature of approximately 500 degrees Fahr. before it will conduct electric current. Mr. Hodson, Electric Furnace Construction Co., London, Eng., later took exception to this statement, claiming that after current has once passed through the hearth, it will flow even when the bottom is cold. Mr. Hodson also differed with Mr. Armstrong on the seriousness of the electrode problem, saying that very little trouble is caused by faulty electrodes. In defending the trunnion tilting arrangement for small furnaces, Mr. Minnick claimed that the unusually small space required for the tilting mechanism is a marked advantage.

C. F. Hirshfeld, Edison Illuminating Co., Detroit, read a paper entitled "The Electric Furnace from the Central Station Standpoint", written by E. L. Crosby, Detroit Edison Co., Detroit. This paper appears in full elsewhere in this issue of THE FOUNDRY.

Malleable Men Discuss Practical Problems

THE constantly growing interest in malleable foundry problems was again attested in the enthusiastic malleable session held Wednesday morning with J. P. Pero, president of the American Foundrymen's association, in the chair. Although covering a wide range of subjects, the discussion centered around the use of pulverized coal in air and annealing furnaces and in the various features of annealing practice.

The following papers were read and discussed: "The Theory of the Modern Waste-Heat Boiler and Possible Application of Such Boilers to the Malleable Melting Furnace," by A. D. Pratt, Babcock & Wilcox Co., New York; "Application of Waste-Heat Boilers to the Malleable Melting Furnace," by C. D. Townsend, Danville Malleable Iron Co., Danville, Ill.; "Application of Pulverized Coal to the Air Furnace," by W. R. Bean, Naugatuck Malleable Iron Works, Naugatuck, Conn.; "Application of Pulverized Coal to Malleable Melting Furnaces," by Joseph Harrington, Chicago; "How Malleable Iron Has Improved," by Enrique Touceda, Albany, N. Y.; "Troubles Encountered in Machining Malleable Iron—Causes and Remedies," by A. T. Jeffery, Dayton Malleable Iron Co., Dayton, O.; "Comparative Carbon Losses in Malleable Iron Annealing by Muffle and Pot Oven Methods," by Joseph B. Deisher, T. H. Symington Co., Rochester, N. Y.; "The Effect of Iron Oxide in Molding Sand," by W. R. Bean, Eastern Malleable Iron Co., Naugatuck, Conn.

Waste-Heat Boilers

The papers on waste-heat boilers by Messrs. Pratt and Townsend were presented by title.

Considerable discussion was created by the presentation of the two papers on pulverized coal by Joseph Harrington and W. R. Bean, respectively.

At the outset, Mr. Harrington states that melting malleable iron with powdered coal must still be considered in the experimental stage. "The assurance that its advocates feel," he continues, "comes from an analysis of the requirements for melting and the definitely defined results that can be obtained with this fuel in securing controllable temperatures." The ease with which the charge can be melted rapidly with powdered coal is pointed out. Flame temperatures in excess of 3000 degrees may be produced with powdered coal. The effect of powdered coal fuel on the furnace lining is discussed, together with its influence on the character of the slag through the introduction of melted ash from the fuel. All the evidence, the author states, points to the fact that with powdered coal there is a decrease in the amount of carbon burned out of the bath to the extent of 2 to 5 per cent.

In spite of its manifest advantages, however, malleable foundrymen are reluctant to take up powdered coal in earnest. "It is certainly a case where precedent is strong," the author concludes, "and the reluctance of foundrymen to take the first step will probably be balanced by their eagerness to fall in line just as soon as the pioneer has completed his work.

Mr. Bean based the need of mechanical firing on the lack of uniformity in hand firing. Mechanical stokers have not yet solved the problem, while the use of pulverized coal gives promise of success. Mr. Bean describes and discusses the results of tests covering 36 heats in an air furnace using pulverized coal. Coal whose ash has a low fusing point has an advantage over that in which the fusing point of the ash is high. Pulverized coal fires are easily started, and with reasonable care, no difficulty should be experienced from smoke or coking. It is suggested that pulverized coal furnaces offer an opportunity for the employment of waste-heat boilers and admit the possibility of using silica brick in furnace linings. The advantages derived from pulverized coal firing are elimination of exhaustive labor, the solution of the clinker problem, a reduction in the cost of fuel, the elimination of smoke, a more advantageous use of waste-heat boilers, and a reduction in the cost of furnace maintenance. Tabulated results of tests are given.

Stanley G. Flagg III, Stanley G. Flagg & Co., Philadelphia, recommended mechanical firing but said he believed oil is more easily adapted to the air furnace than pulverized coal. In reply, Mr. Bean said open-hearth furnace experience has shown that pulverized coal is preferable to oil even at 2 cents a gallon. He said he believed oxidation is more difficult to control with oil than in the case of hand-fired coal furnaces and that it is difficult to reach high enough temperatures. President Pero countered with an enthusiastic recommendation of fuel oil for air-furnace use based on favorable experiments at the plant of the Missouri Malleable Iron Co. Hand firing, said Mr. Pero, is doomed. Mr. Bean said the relative cost of coal and oil depends entirely on the respective heat values and unit prices of the two fuels in given localities, concluding with the statement that in his judgment the furnace is more easily controlled with pulverized coal than with oil.

Mr. Flagg asked if the dust from powdered coal installations is offensive to the neighborhood where the furnaces are installed. Mr. Bean pointed out that very little dust can pass the melting zone. About 1600 pounds of ash are formed in melting down a 20-ton heat. The use of a combustion chamber helps to control the dust nuisance which is less tractable in the annealing furnace than in the air furnace. Referring to Mr. Harrington's paper, Mr. Bean said he doubted if a temperature of 3000 degrees can be reached with powdered coal, the maximum range being nearer 2800 degrees, with a temperature of 2500 degrees at the stack base.

How Malleable Has Improved

In his paper on the improvement of malleable iron Mr. Touceda presents in tabular form the results of thousands of malleable iron test bars produced by a number of different founders during 1915, 1916 and 1917. The figures show a steady improvement in the quality of the metal. In addition, data from individual shops are given to show that uniformly good results are being obtained, and in the opinion of the author, uniformity of product is more important than high tensile strength. The figures covering bars tested in 1915, 1916 and 1917 show that in 1915 the proportion of bars that failed to test up to 40,000 pounds was 5.80 per cent; in 1917 it had dropped to 1.68 per cent. Only 2.40 per cent of the bars exceeded 5200 pounds in 1915; in 1917 18.49 showed better than this figure. The author believes the test data presented show that, provided the casting is sound, high quality malleable iron can be produced today just as easily in sections around 1¼-inch thick as in the case of the ⅝-inch sections. A. T. Jeffery's paper on machining malleable iron is published in full elsewhere in this issue. Stanley G. Flagg III pointed out that all complaints from the machine shop should be carefully investigated. Many foundrymen, he stated, are too easygoing in this particular. Therefore they are imposed upon and replace returned castings, the acceptance of which should be insisted upon.

In a similar complaint, C. H. Gale, Pressed Steel Car Co., McKees Rocks, Pa., pointed out that in many cases customers say castings are too hard when as a matter of fact they are in reality too soft and tough. E. H. Wood asked what is the ultimate machining speed of malleable iron. Prof. Touceda replied that malleable can be machined at brass speed, that is about 150 feet per minute.

Pot vs. Muffle Annealing

The paper presented by Joseph B. Deisher on carbon losses in annealing deals with the various factors entering into the heat treatment of malleable castings in muffle and pot ovens. According to the author the safe annealing temperatures are from 1450 to 1650 degrees Fahr. for pot ovens and from 1500 to 1700 degrees for muffle ovens. Mr. Deisher believes that the 60 hours usually considered necessary to completely dissolve the iron carbide are not actually required and that the best practice is to bring the castings to the highest temperature at the beginning of the anneal, such temperature to be held until the iron carbide is dissolved, and then drop to 1400 degrees, which is considered favorable for the precipitation of the graphitic carbon. In a comprehensive discussion of the advantages and disadvantages of the pot and muffle ovens, the author concludes that the conversion rather than the removal of carbon in the anneal produces ductility. This contention seems to be borne out by the results of tests made with castings which were annealed in mild packing, strong packing and without packing of any kind.

L. W. Marcus, metallurgist, Rhode Island Malleable Iron Co., opened the discussion by pointing out that the time required for the disassociation of carbon is fixed but that the time consumed in getting up to proper temperature may be controlled within certain limits. Annealing time could be cut down, he said, if the furnace temperature could be more readily controlled at the critical range. Enrique Touceda recommended very slow cooling during the incipient stages of the anneal. He suggested seven to eight degrees per hour for the first 15 hours and not over 10 degrees per hour for the next 15 hours. The cooling down to the critical point, 1250 degrees, he said, should be as slow as possible. Below 1200 degrees, Mr. Deisher said, the castings "could be cooled in ice water".

C. H. Gale said the carbon loss in annealing in his experience is invariably around 1 per cent, instead of from 0.35 to 0.65 per cent, as stated by Mr. Deisher. A. L. Pollard, Johnston Harvester Co., Batavia, N. Y., confirmed Mr. Gale's figures. The carbon loss can be reduced, he said, by packing in an inert material such as sand.

In his paper on iron oxide in molding sand, W. R. Bean declares that the presence of oxide is detrimental to good surface finish of castings. This conclusion is based on three experiences of the author with sand containing the oxide. When dust taken from a dust arrester was added to the molding sand, the metal washed away the sand in the parts of the mold surface. Sand analyzing 5 per cent iron oxide became so hard in pockets of the castings that it could not be removed in cleaning. In a third instance the addition of sand containing iron oxide formed a lumpy mixture which could not be reduced to the proper degree of fineness for use as molding sand. According to the author, the best surface finish is obtained by using a facing of new fine molding sand put through a mixer without the addition of sea coal facing or any other element. Nature seems to blend the silica and alumina, the principal elements in molding sand better than we can do it by mechanical means.

Stanley G. Flagg III confirmed Mr. Bean's conclusions regarding the advisability of dispensing with facings in molds for small castings. In addition, he said the sand should be as dry as possible. R. W. E. Hayes. Hayes Pump & Planter Co., Galva, Ill., said his experience agreed with Mr. Bean's.

Borchers electric furnace consists of an iron casing with a refractory lining and a bottom containing a water-cooled steel block which is connected to one pole, while the other connects with a vertical, movable electrode. The furnace has a tap hole.

The Dunham Co., Berea, O., has moved its general offices to 801-4 Hippodrome building, Cleveland. This company manufactures rollers and pulverizers, and also turns out gray iron castings for automobile manufacturers. The factory and foundry will remain at Berea.

Major Henry Souther, formerly vice president of the Ferro Machine & Foundry Co., Cleveland, died at Fort Monroe hospital Aug. 22 at the age of 52 years. He was recently commissioned a major in the army and appointed an officer in charge of the Langley aviation field.

Institute of Metals Puts in a Busy Week

Papers Dealing With Wide Range of Subjects Read and Discussed —Special Session on Use of Nonferrous Metals for Munitions

THE annual meeting of the American Institute of Metals held at Boston, Sept. 24 to 28 concurrently with the convention of the American Foundrymen's association was replete with interesting discussions of both foundry and metallurgical problems. The opening session was held jointly with the American Foundrymen's association in the Mechanics building on Monday afternoon, Sept. 24. The details of this session are covered in the report of the proceedings of the American Foundrymen's association elsewhere in this issue.

President's Address

Jesse L. Jones, Westinghouse Electric & Mfg. Co., Pittsburgh, president of the American Institute of Metals, presented his annual address at the joint meeting. In part, this address is as follows:

"The period that has elapsed since the beginning of the war has been marked by great progress in nonferrous technology. Under the spur of necessity, many articles previously imported had to be made in our own country because they could no longer be obtained abroad. New problems also arose constantly in connection with the manufacture of munitions.

"Foremost I may mention the commercial production of electrolytic zinc. Previous to the war the market for high-grade zinc was rather narrow. With the placing of munitions contracts which called for brass with less than 0.1 per cent lead, the demand was greatly augmented and the price mounted rapidly as the firms making high-grade zinc by distillation processes did not have enough capacity to supply the unusual market. This resulted in a number of firms engaging in the manufacture of electrolytic zinc, it even being found profitable to cast anodes from prime western spelter and electrolytically refine them. In some cases a purity of 99.98 per cent has been obtained. It will be interesting to users to see whether the electrolytic zinc is able to compete in purity, uniformity and price with the high-grade distilled zinc. If the two processes give equally good results there should be a broader market for high-grade zinc after the war when prices are lower and supplies abundant. The thin, tough coating that this grade of zinc gives, warrants its extensive use in hot galvanizing. It can also be used advantageously in high-grade manganese bronze, aluminum alloys, sheet brass and die cast alloys.

"Instead of the production of electrolytic zinc cathode sheets, the product can be converted into zinc dust. As this zinc dust is very pure it opens the way for improvements in the sherardizing process, it being recognized that the purer the zinc coating on an iron or steel article, the better it will be protected from corrosion.

Large Slime Accumulations

"The production of electrolytic zinc has resulted in the accumulation of large amounts of slimes or residues high in cadmium. Electrolytic cadmium has been produced experimentally from these slimes and I would suggest active research work in developing new uses on a large scale for metallic cadmium.

W. M. CORSE
After Effective Service as Secretary Elevated to the Presidency of the American Institute of Metals

"Quite recently the production of electrolytic tin has been announced. The difficulty of obtaining Straits tin makes the advent of the electrolytic tin doubly welcome. In the electrical industry, in particular, extremely pure tin is essential as the connectors of electrical apparatus require the use of the highest grades of tin obtainable.

"The demand for alloys for aeroplane work has brought magnesium into prominence. This metal which came entirely from abroad, can now be had in any desired amount from American makers. The extreme lightness of its alloys with aluminum, the high speed at which they can be machined and their relative cheapness bulk for bulk should result in a constantly increasing demand for magnesium.

"The scarcity and high price of antimony has led to the development of a novelty in the shape of electrolytic babbitt. This contains no antimony or tin necessarily but consists of lead hardened by small amounts of the alkaline earth metals, barium, calcium, etc.

"The crucible makers of the United States have been handicapped by inability to obtain the Ceylon graphite and Klingenberg clay they formerly used. With characteristic American energy and ingenuity, however, they have already so adapted the clays and graphite which are available that very fair results are being obtained except possibly on the larger sizes of crucibles. The high price of crucibles has led to the rapid adoption of electric furnaces for melting nonferrous metals. Both carbon resistor and induction types of furnaces seem to be doing satisfactory work in melting brass for rolling into sheets for cartridge cases, etc. For foundry work where light castings are run and hot metal required not so much progress has been made.

"This list of nonferrous achievements could be much extended but I will mention only one thing more. Recently, when the demand for copper driving bands was so urgent that the tube mills could not meet it, a number of foundries succeeded in producing very satisfactory copper castings for this purpose. When rolled into bands, physical characteristics equal to those found in the drawn tubes were obtainable. In the opinion of many ordnance experts these bands because they are rolled radially are superior to those cut from tubes which are drawn lengthwise. The greatest care is required in order to obtain copper castings that will be sound and clean."

The first professional session of the American Institute of Metals was held at the Hotel Somerset at 9:30 a. m., Tuesday, Sept. 25, with President Jones in the chair. The initial paper was entitled "Raw Materials Used for Crucibles", by Prof. A. V. Bleininger, United States bureau of standards, Washington, D. C. This paper, which was read in abstract in the absence of the author, deals with the manufacture of crucibles from the selection of the raw materials to the completion of the annealing of the finished article. The raw materials are graphite, sand and fire clay. The specific gravity and various other properties of graphites are given. Crucible making is so old an art that it is difficult to present anything new concerning it; consequently, while Prof. Bleininger evolved a very interesting paper, many of those present during its presentation were fairly familiar with the facts brought out.

In the discussion that ensued, M. McNaughton, Joseph Dixon Crucible

Co., Jersey City, N. J., said crucibles cannot be improved in density by exposure to high temperatures. Jesse L. Jones, Westinghouse Electric & Mfg. Co., East Pittsburgh, mentioned the fact that the larger a crucible, the poorer it is likely to be, and George C. Stone, New Jersey Zinc Co., Palmerton, Pa., gave an explanation of this peculiarity by citing some of the difficulties he had encountered and the precautions he had found it necessary to take to obtain good results in making zinc retorts. In making these retorts, which are of similar raw materials to crucibles, it is imperative that the material be graded to certain sizes depending upon whether a large or small retort is to be made. Possibly, he said, crucible makers may be using a uniform size of raw material for both large and small crucibles. The large crucibles fail and the small ones do not, due to the fact that while the grain size of the raw material is suitable for the small crucible it is not adapted for larger ones.

He also emphasized the importance of slowly drying the green crucibles or retorts. The drying should extend over a period of months, and when properly accomplished tests have shown that the tensile strength of the crucible material is double that obtained when the vessels are too rapidly dried, and when the grain size of the raw materials is not uniform and adapted to the particular size of the retort.

Melting Bars in Electric Furnace

A paper was presented by G. H. Clamer, Ajax Metal Co., Philadelphia, entitled "Melting Yellow Brass in New Form of Induction Furnace". No one kind of electric furnace, remarked Mr. Clamer, is suitable for melting all the different alloys and the particular furnace he described which is known as the Ajax-Wyatt induction furnace is at its best when melting yellow brass, manganese-bronze, muntz metal, and similar high-zinc alloys. He then outlined some of the conditions under which induction furnaces are operated and the difficulties to be guarded against including the "pinch effect" and low power factor. Diagrams were shown illustrative of single-phase type, horizontal-plane, induction furnaces. The first closed type of induction furnace was invented by Charles P. Snyder, Creusot, France, and several diagrams were shown to illustrate the principle on which this furnace worked.

A very interesting paper was read by W. H. Parry, National Meter Co., Brooklyn, N. Y. This paper was on "My Experience with Metal Melting Furnaces", and described some of the troubles encountered during the installation and initial operation of a furnace for melting reclaimed brass foundry wastes. These difficulties were largely due to the lack of available data concerning such furnaces. Practical experience had shown that the material before melting should be thoroughly cleansed of all gangue, which is accomplished by crushing, washing, concentrating and drying, then again washing to float off all emery dust. The clean material is separated into fine and coarse, and the charge consists of one-third fine and two-thirds coarse material. Iron is removed by a separator, and experience has shown this is best effected by working the material in a thin layer no deeper than the size of the chips. In the opinion of the author, skillful manipulation is the most necessary factor in the situation.

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A paper on "Shrapnel Bullets", was presented by Harold J. Roast, James Robertson Co., Ltd., Montreal, Que. The alloy used for shrapnel bullets consists of 12.5 per cent antimony and 87.5 per cent lead. Segregation of the antimony was found a source of difficulty which was finally overcome by a constant and thorough stirring of the metal bath and by casting in water-cooled molds. The discussion brought out several suggestions for avoiding segregation, one being to add the antimony in a powdered form to the molten lead, and another being to melt the lead and antimony separately, one in a kettle, the other in a crucible, and pour the liqid metals together.

An interesting method of making tin babbitts was described by Charles Pack, Doehler Die Casting Co., Brooklyn, N. Y. This consists in first melting the tin, covering with a flux of zinc chloride and introducing the copper or antimony or both through the flux which caused them to become tin coated, and by thus preventing oxidation, made them easily soluble in the tin. The variation of analysis by this method was 0.2 per cent antimony.

"Recent Industrial Uses of Aluminum" were discussed by F. G. Shull, Aluminum Co. of America, Boston. Mr. Shull gave a list of the more modern uses that have developed for aluminum, comprising aluminum foil, aluminum bottle caps, autogenous welding operations, die and pressed castings, pneumatic tubing for intercommunication in stores, rolled rod for machining purposes and aluminum conductors, steel reinforced.

Two papers were withdrawn from the program of this session. They were "The Use of Die Castings in Munitions", by Charles Pack, Doehler Die Casting Co., Brooklyn, N. Y., which could not be presented owing to an embargo on this information placed by the war department, and the paper on "The Consumption of Copper and Its Varied Uses", by H. D. Hawks, United Metals Selling Co., New York.

The secretary-treasurer's report shows that the institute on July 1, 1917, had 282 active and 64 associate members, making a total of 346. In the active membership are included the corporation memberships, rated as three active members each. The most important feature of the current year has been the adoption of the plan to issue a quarterly journal of the annual volume of transactions. The secretary's report also states that many members of the institute have been called upon by the government to serve in various capacities of a technical nature.

The first paper presented at the Thursday session of the American Institute of Metals was, "Comparative

Tests on Test Bars and Actual Castings," by W. M. Corse, Titanium Alloy Mfg. Co., Niagara Falls, N. Y. The method adopted in making the test bar and of obtaining it from the casting is described in the paper. The separately cast test bars were run with a fin-gate which permitted a maximum feeding effect, and the test bars from the castings with which they are compared were cut directly from the castings, and in some cases were in the form of thin, flat strips. The object in presenting these tests is to direct the attention of the designing engineer to the fact that the average of a number of physical tests should not be used to originate minimum specifications for physical properties of alloys. These average results would be much higher than could possibly be obtained from castings made in the ordinary manner. Owing to the structural design of the latter it was seldom possible to feed metal to supply the intercrystalline shrinkage, to the same extent as in the case of the separately cast test bars, consequently specifications formulated in the manner outlined were only met by manufacturers with great difficulty and at the expense of many failures.

Speeding Up Analyses

The second paper, entitled "Analyses of Brass, Bronze and Babbitt", was read in abstract in the absence of the author, E. W. Hagmier, Superior Rubber Co., Inc., Buffalo.

The paper on "The Flux and Cleaner Question of Brass", by E. D. Frohman, S. Obermayer Co., Pittsburgh, was read by proxy. The various substances that are commonly used as fluxes for brass are reviewed and the fact is brought out that it is the aim of the manufacturers of the special flux to create an atmosphere of carbon monoxide gas in contact with the molten metal which it is contended would reduce some of the oxides to the metallic form. Instances of successful operation of the flux are cited.

In the discussion, the opinion was expressed that the province of a flux as such is limited to use in the case of metals contaminated with nonmetallic matter with which the flux can unite to form a fluid slag which automatically arises to the surface of the metal, thus freeing the latter from its combination. President Jones had found the flux in question useful, but analysis showed it to consist of fine coke dust mixed with clay. It was brought out that an efficient cover for molten brass is salt mixed with plaster of paris, especially in the case of open-flame melting furnaces. Tests on ingot from sheet copper melted in contact with a salt and plaster flux had shown the cuprous oxide was reduced, being less in the ingot than the sheet. A question arose as to the chemical action of the salt, and the hypothesis was advanced and accepted that the deoxidizing effect was due to the reduction from the salt of nascent sodium by the high temperature of the furnace and the action of the carbon present.

G. H. Clamer, Ajax Metal Co., Philadelphia, thought that too much attention was given to oxygen and not enough to the sulphur present and others agreed with this view. As a result of this discussion Mr. Clamer suggested that a committee be appointed by the institute to investigate the merits of fluxes so that a recommendation of a dependable one could be made. Although the suggestion was not a motion, it was seconded by C. P. Karr, bureau of standards, Washington. The suggestion was referred to the executive committee for action.

Development of Pyrometers

"Pyrometers — Their Construction and Application," by John P. Goheen, Brown Instrument Co., Philadelphia, was the next paper read. The author touches on the early history of the pyrometer, stating that the first pyrometer made in the United States was of the expansion type and was produced in 1860. This pyrometer measured up to 900 degrees Cent. The difference between the single suspension types and the double pivoted types of pyrometers is shown and the general improvements lately made are discussed. The discussion brought out the fact that no entirely satisfactory protecting tube for the thermo-couple is known.

The next paper presented was entitled "Electrically Heated Core Ovens", by Dr. C. F. Hirshfeld, Edison Illuminating Co., Detroit. This was followed by a paper on "Brass Foundry Core Practice", by H. M. Lane, Detroit. A uniform size of grain should be aimed at in selecting sands for cores as this gives maximum venting properties.

Final Session

The concluding session of the American Institute of Metals was opened with the senior vice president, George C. Stone, New Jersey Zinc Co., New York, in the chair in the absence of President Jones. The first paper on the program, which was read by title, was "The Electrolytic Production of Antimony," by Prof. D. J. Demarest. Ohio State University, Columbus, O.

The second paper, "The Electrical Properties of Some High Resistance Alloys", by Prof. M. A. Hunter, Rensselaer Polytechnic Institute, and F. M. Lebast, Troy, N. Y., was read in abstract by Prof. Hunter. In the discussion that followed it developed that chromium and copper form what might be termed a metallic emulsion and that the union of chromium and copper is analagous to the union of oil and water when emulsified, instead of being a true alloy. These admixtures, however, do not segregate, tests have shown, up to a content of 20 per cent chromium.

A paper entitled "The Amorphous Theory in Metals", by Zay Jeffries, Aluminum Castings Co., Cleveland, O., followed. It was a highly technical, but very interesting paper, which, on account of its length, will be reserved for a future issue of THE FOUNDRY. The thanks of the meeting were extended to Prof. Jeffries for his valuable contribution to the literature of the brass metallurgist.

The paper on "The Volatility of Zinc and Cadmium", by John Johnston and Edward Schramm, American Zinc, Lead & Smelting Co., St. Louis, was withdrawn, and the papers entitled "Surface Tension and Deoxidizing of Metals", by W. J. Knox, Metals Deoxidizing and Refining Co., New York, and "Antimony—Its Metallurgy and Uses", by K. C. Li, Wah Chang Mining & Smelting Co., Inc., New York, were read by title.

"The Development and Reabsorption of the Beta Constituent in Alloys which are normally of the Alpha Type", by Prof. C. H. Mathewson, department of mining and metallurgy, Yale University, and Philip Davidson, New Haven, Conn., was read in abstract. The thanks of the meeting were extended to Prof. Mathewson for his paper.

The last paper on the program, entitled the "Swelling of Zinc Base Die Castings", by H. M. Williams, National Cash Register Co., Dayton. O., was read by title.

Shorter Sessions Next Year?

Secretary Corse announced that at the request of the executive committee he would ask for an expression of opinion from the members as to the advisability of curtailing the length of the sessions at the next meeting.

W. H. Bassett thought the present sessions had been very skilfully arranged with the intention of holding the interest of the members to the last. He felt, however, that the time required for the sessions could be materially shortened and suggested holding evening sessions.

Exhibits at Boston Reflect War's Influence

Display of Foundry Equipment Reveals Greater Interest in Labor Saving Devices, Standardization, and Problems of Munition Manufacture

THE reaction of American industry to war conditions was clearly evident in the twelfth annual foundry and machine exhibition at Boston, Sept. 24 to 28. The show was larger than ever, the exhibits more varied in character and every manufacturer evidently had made a special effort to display equipment and products of special value in the present emergency.

Not only was the show the largest of its kind, but the attendance far surpassed previous efforts. It is estimated over 2500 persons passed through the entrances during the week. The two vast floors of the great Mechanics' pavilion were crowded with exhibits. As the accompanying illustrations indicate, the show was unusually well arranged and beautifully decorated. Well lighted rooms and high arched ceilings contributed materially to an attractive general effect.

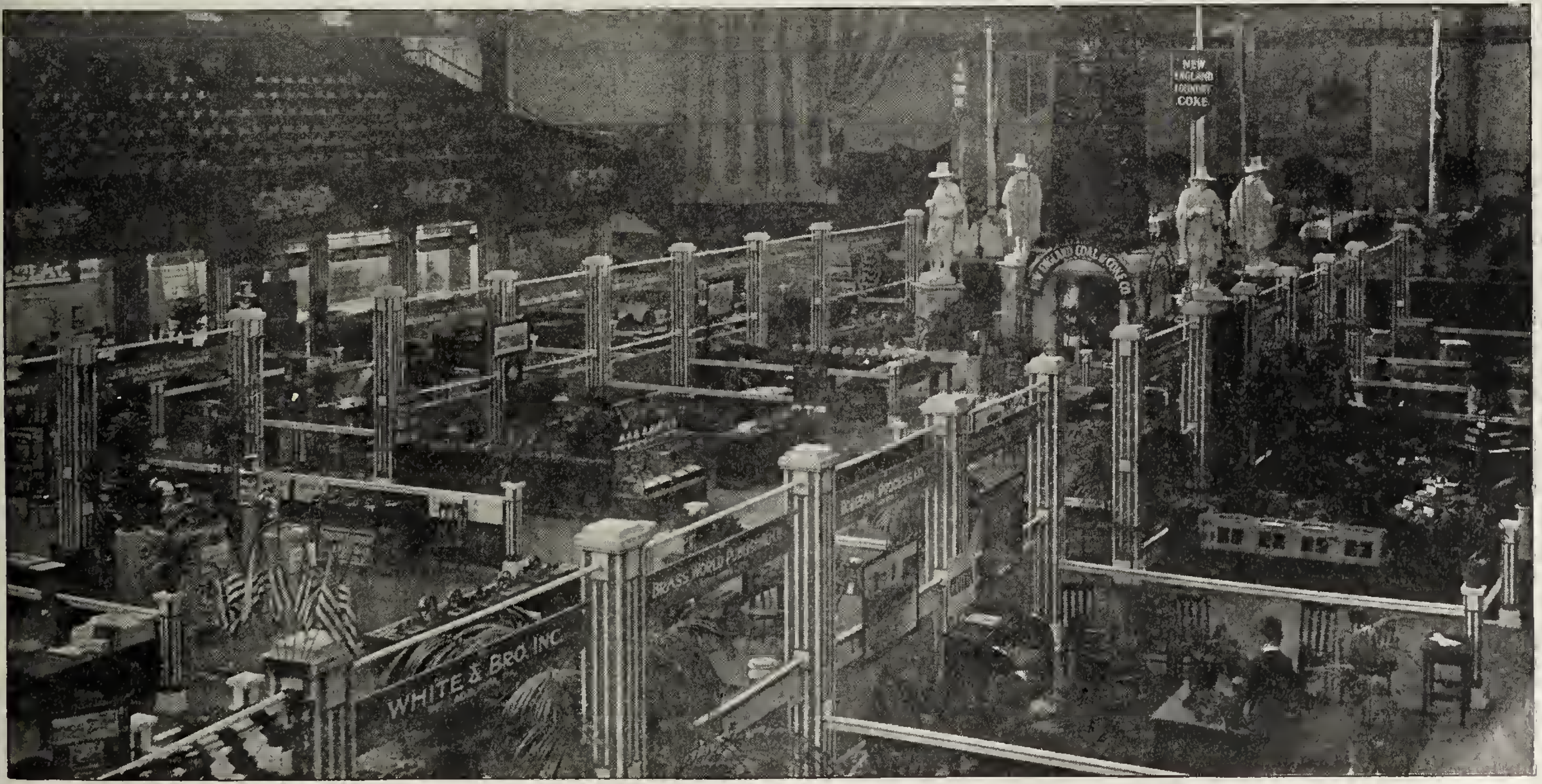
A large number of army and navy officers attended the show. It was evident from their interested inquiries and frequent conferences with plant experts that the industrial and military forces of the country are being thoroughly co-ordinated to win the war.

As at several previous exhibitions, molding machines and sand-blast apparatus held the center of the stage. Over 60 molding machines and 15 sand-blasting outfits were in operation throughout the week. The very latest types, of course, were displayed for inspection. In fact, the annual recurring foundry and machine exhibitions afford an excellent opportunity to make both quantitative and qualitative analyses of the year's progress in the manufacture of foundry and shop appliances of all kinds. Furthermore, if the shows offered no further advantages, they would be well worth while, for it has long since been demonstrated in the foundry industry that the rate of progress is dependent almost directly on the effectiveness of the available facilities for the interchange of information. The molding machine manufacturers particularly appreciate the opportunity once a year to meet not only their customers, but their competitors.

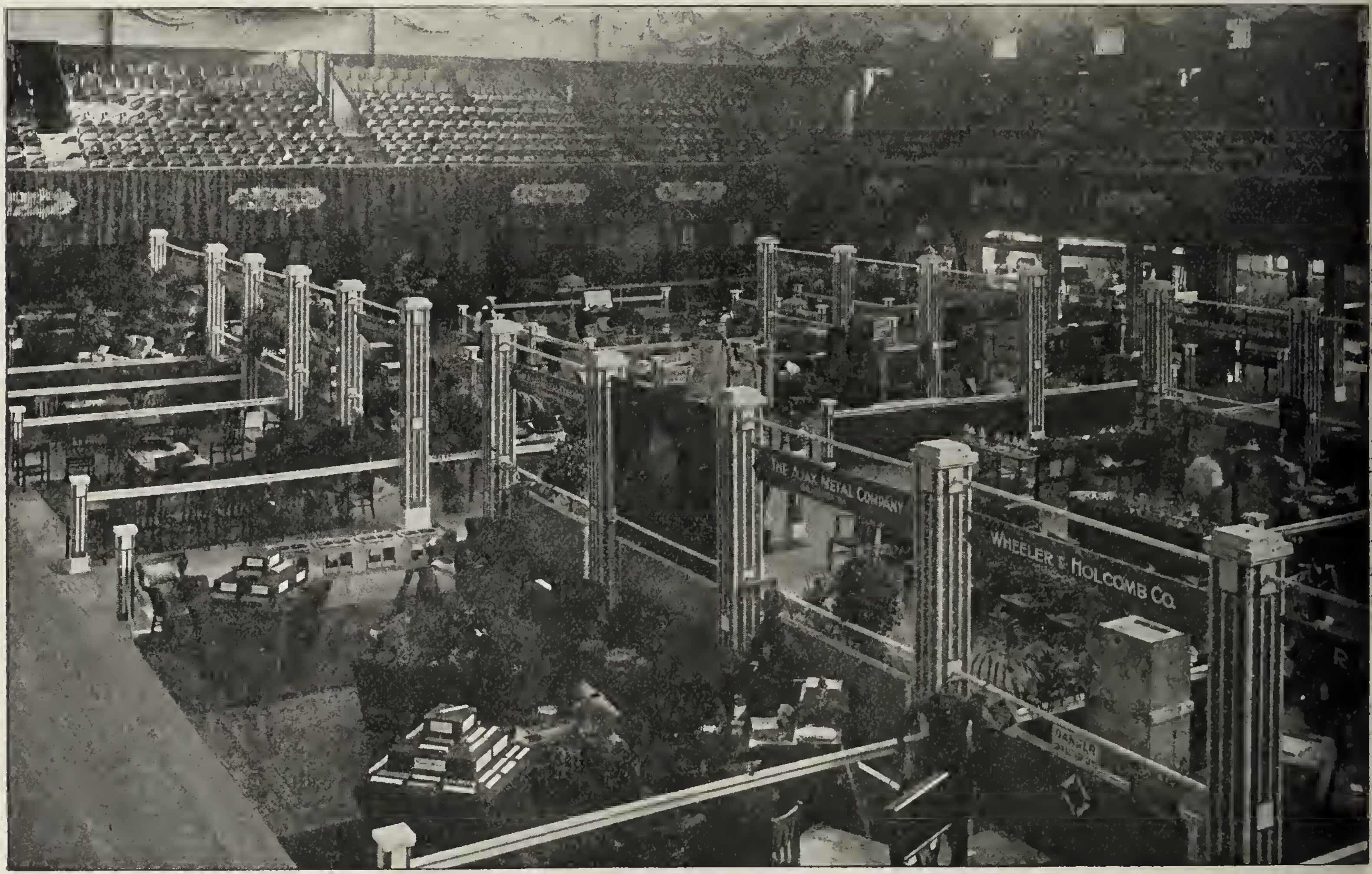
ARTISTIC EXHIBIT, NEW ENGLAND COAL & COKE CO.

A survey of the exhibits at the Boston show leads easily to the conclusion that molding machines are now thoroughly standardized. Radical innovations are the exception rather than the rule. Improvements consist in refinements of detail, and as in the case of the much-heralded Liberty aeroplane motor, in new combinations of thoroughly tested elements. Not over three radically new molding machines were exhibited, but the minor improvements and refinements evident on practically every machine prove conclusively that manufacturers have not been idle during the past 12 months.

At the present stage of the development of the molding-machine business,



GENERAL VIEW OF FOUNDRY EXHIBIT LOOKING WEST IN GRAND HALL attention is being centered on precision in manufacture and improvements designed to still further reduce the manual efforts of the molder. Owing to the widespread shortage of labor, now being augmented by the operation of the selective service law, the demand for machines that will save human effort on the molding floor is more insistent than ever. Furthermore, molders are constantly becoming more captious, and in some sections of the country even arrogant, with the result that foundrymen see more keenly than usual the necessity for machines designed not only to replace men, but to reduce to a minimum, the demands on the muscles and intelligence of the relatively few operators that may be required. Molding-machine manufacturers are fully awake to this situation and they are co-operating with the foundrymen with characteristic energy. The latest machines, such as those displayed on both floors of the great Mechanics building at Boston, perform all of the operations connected with making a mold, some of them even being provided with auxiliary apparatus for filling the mold with sand and for carrying away the completed flasks. In many cases, the workman is called upon to do nothing more fatiguing than operating an air valve or electric switch. In superiority of finish and precision in the manufacture of its working parts, the molding machine of 1917 forms a striking contrast with its predecessor of 1907. Today many molding machines are machine tools in the fullest sense of the word: their parts are as accurately made and carefully fitted as those of a fine lathe or milling machine. In many cases, the moving parts run in an oil bath and the design is such that no sand can find its way into the bearings or between fitted surfaces. It is such refinements as these that make it possible to use molding machines for the production of high-power, complicated, multi-cored automobile and aeroplane cylinder blocks with metal sections pared to 5/32-inch. In fact, in such cases the machines turn out work that the most skilled hand-molders cannot duplicate. In spite of these improvements, molding machines are relatively cheaper at the present time than they were in the neighborhood of 10 years ago.



GENERAL VIEW OF GRAND HALL, MECHANICS BUILDING DURING THE TWELFTH ANNUAL FOUNDRY AND MACHINE EXHIBITION

A Simplified Roll-Over Machine

An unusually interesting machine of a new type was displayed by the American Molding Machine Co., Terre Haute, Ind. This machine, which was shown in operation, was designed by W. C. Norcross. It is of the combination roll-over jolt type, pneumatically operated. Instead of employing separate units, however, the roll-over and ramming functions are controlled by a single air cylinder. When jolting the mold, this cylinder operates in the usual manner. For the roll-over operation, a unique link-motion and an automatic latch are brought into play. The mold is balanced at the center and virtually no force is required to roll it over. An oil-filled balancing cylinder is provided to steady the roll-over operation. The flask is turned onto an automatic ball-and-socket leveling device that is self compensating for any irregularities in the flask or mold. The machine exhibited was provided with a 30 x 40-inch table and a cylinder 10 inches in diameter.

The American Molding Machine Co. also exhibited a combination jolt-stripping plate machine with a 24 x 36-inch table and a 12-inch draw. One cylinder jolts the flask and draws the pattern. The stripping operation is performed by first raising the flask to the full height of the draw, in which position it is held by four steel rods. The pattern is then drawn through the stripping-plate by exhausting the air slowly from the cylinder. The four rods that hold up the flask and stripping-plate are supported by spring-actuated dogs which automatically engage slots milled in the lower ends of the rods

The new Morrison electric jolt-machine was exhibited by The E. J. Woodison Co., Detroit. This machine has a number of features which tend to make it easy for a relatively ignorant or inexperienced handyman to operate it. It is claimed in particular that it is virtually impossible for the operator to ram the mold either too hard or too soft. This is accomplished by providing the machine with a dial that registers the number of blows; every flask therefore can be correctly rammed. The machine is driven by a motor placed on a column. The jolt, which is produced by a cam-wheel mechanism, is controlled by a hand lever on the side of the machine. The roll-over feature is operated by a crane arm provided with a cable, one end of which is wound around a drum on the cam-wheel shaft. The jolt is received on four steel anvils. The pattern is drawn by means of a socket wrench fitted on the end of a shaft. This is accomplished after the flask is rolled-over; therefore, no leveling device is necessary. The machine exhibited will take flasks up to 20½ x 40 inches A 12-inch pattern draw is provided.

Mold with 800 *Pounds of Cores*

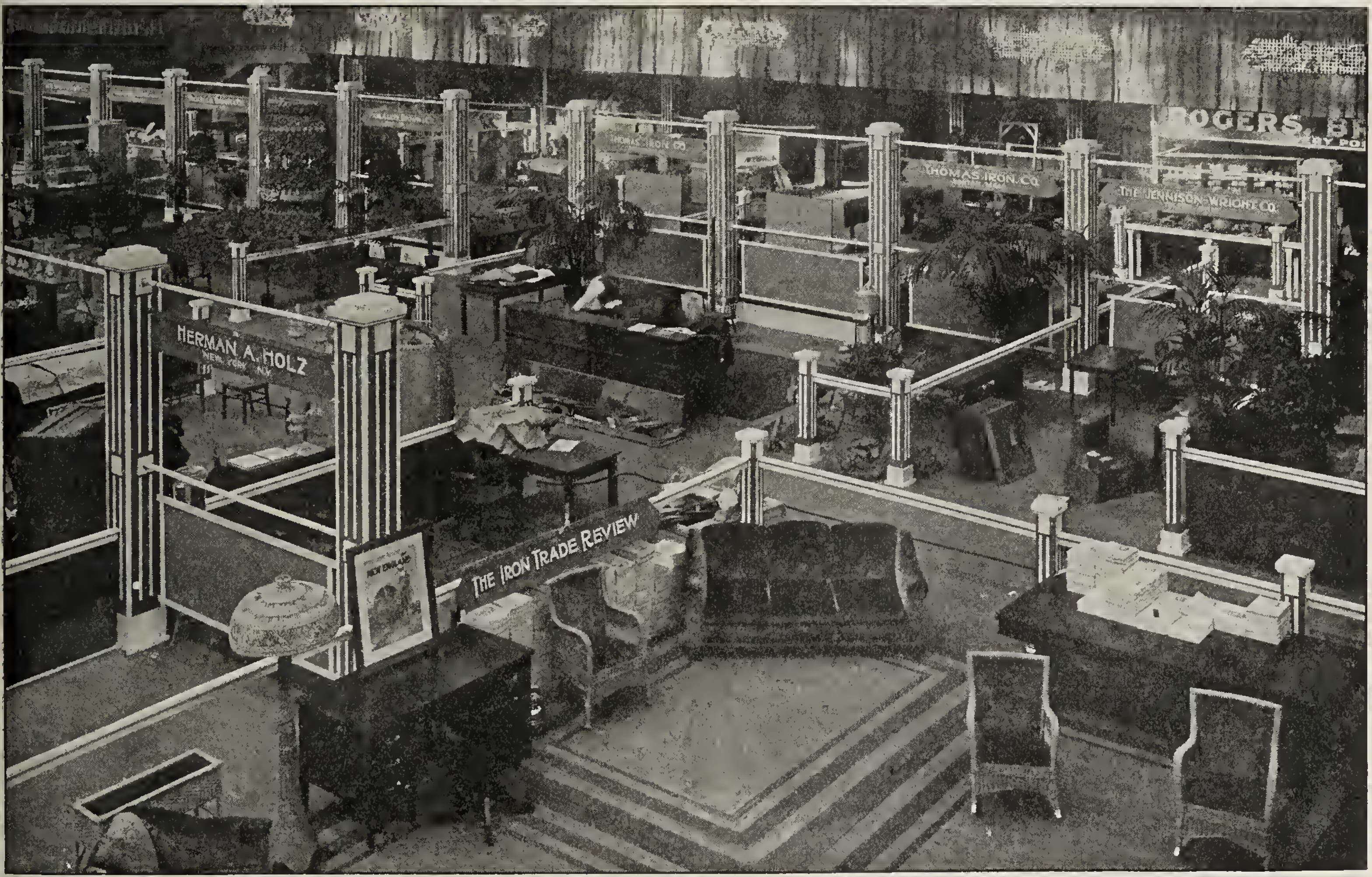
The central feature of the exhibit of the Osborn Mfg. Co., Cleveland, was a 260-horsepower 6-cylinder aircraft-motor casting made on an Osborn jolt-ramming machine. This casting is one of a lot manufactured by Allyne-Ryan Foundry Co., Cleveland, for the Kessler Motor Co., Detroit. It is an excellent example of the possibilities of the modern molding machine. The metal sections in some places are less than 3/16-inch and each mold contains 800 pounds of cores. The Osborn company also exhibited a combination stripping-plate squeezer machine, and a number of plain, pneumatic jolt-ramming machines, together with other examples of its labor-saving molding devices. The well-known molding machines manufactured by Henry E. Pridmore, Chicago, were shown in operation. In the past year a number of refinements and improvements have been introduced, for the purpose of making the machines easier to operate and more accurate in action. A new 20 x 24-inch combination jolt-stripping-plate machine, with electric jolt and pneumatic stripping action was shown in operation making molds for Ford rear-axle housings. A 36-inch combination air-electric rock-over jolt machine was displayed, together with a 24-inch plain pneumatic rock-over drop machine of the type originated by the late Henry E. Pridmore. The visitors during the week displayed considerable interest in an aluminum model of a Pridmore electric jolt-ramming machine. The model was sectionalized so the functions of the various working parts were clearly visible. A number of fine, intricate gray-iron castings made on Pridmore machines also were exhibited. These castings were remarkable for the precision with which they were molded and the excellence of the finish.

Displays Electric Molding Machine

As usual, a complete exhibit was presented by the Arcade Mfg. Co., Freeport, Ill. A new 24-inch electrically-operated, roll-over, jolt-ramming and pattern-drawing machine was one of the features of the exhibit. Two sizes of plain jolt-ramming machines also were displayed; one was fitted with a ferrule plate. The exhibit also included a combination jolt-ramming squeezer machine, air and hand squeezers, piston molding machines, midget core jar-ramming machines and the Brillion pouring device.

An air squeezer equipped with a pneumatic vibrator and a lifting device was prominent in the exhibit of the Berkshire Mfg. Co., Cleveland. In addition, a complete line of wood, iron and aluminum flasks and specially designed aluminum matchplates was displayed. The match-plates are made of a special metal and where extreme accuracy is desired their use is recommended.

The B. & B. Mfg. Co., Indianapolis, exhibited power and hand squeezers. Both portable and stationary machines



THE BOSTON EXHIBIT WAS NOTABLE FOR ITS ARTISTIC AND TASTEFUL DECORATIONS were displayed. Several sizes and styles were shown.

Machines Without Valves

Jolt-ramming machines without valves were displayed by the Federal Foundry Supply Co., Cleveland. The exhibit included six different sizes of machines. In the operation of these machines, the opening of the exhaust automatically shuts off the intake; the expansive force of the air then forces the piston the remainder of its stroke, fully opening the exhaust. As soon as the pressure is released, the piston drops to its starting point. Six different types of power squeezers and combination jolt-squeezer machines also were shown. The squeezers are provided with extra long cylinders and heavy leather pistons which assist in the conservation of air. One of the combination jolt-ram-squeezer machines had a 4-inch jolting cylinder and a 9-inch squeezing cylinder; the other was equipped with a 5-inch jolting and a 12-inch squeezing cylinder. The plain power squeezers displayed had cylinders 9 and 12 inches in diameter respectively.

Standard plain jar-ramming and combination jar-ramming and squeezing machines were displayed by the Herman Pneumatic Machine Co., Pittsburgh. These machines were not in operation. In addition, the Herman company furnished its booth in a comfortable manner for the entertainment of its customers and visitors.

Specimens of the complete line of molding machines which it manufactures were exhibited by the International Molding Machine Co., Chicago. This exhibit included electric and pneumatic jar-ramming molding machines, plain squeezers, combination jolt-squeezers and the stripping-squeezers, together with hand turn-over draw, power turn-over draw and combination jar-ramming turn-over draw machines. In designing these machines an effort has been made to provide ample reserve strength, together with simplicity of adjustment and accuracy of operation.

A Machine for Women

A small jar-ramming roll-over machine suitable for core-room operation by women was one of the features of the exhibit of the Midland Machine Co., Detroit. This machine can be operated with a minimum of manual exertion, and at the same time cores of uniform quality can be turned out rapidly. Other types of Grimes roll-over molding machines also were displayed, and interesting motion pictures of molding-machine operations were shown.

As at previous exhibitions, the Mumford Molding Machine Co., Chicago, displayed large-scale sectional drawings of its latest type machine which is equipped with a valve action specially designed to produce a maximum ramming effect with a minimum of air consumption.

Swing-head squeezers of the characteristic type invented by William Nicholls were exhibited in operation by Wm. H. Nicholls Co., Brooklyn, N. Y. Two combination jolt-ramming squeezer machines with an automatic gravity pattern drawing device were also displayed by the Nicholls company. Richey, Browne & Donald, Maspeth, N. Y., exhibited their roller-ramming machine which is suitable for certain classes of work.

Swing-head machines of the plain squeeze and combination types were displayed by the U. S. Molding Machine Co., Cleveland. The thrust of the squeeze is absorbed by a heavy T-section casting which is stayed on one end by a forged rod. Six different types of machines were displayed.

HUB OF COKE IN PICKANDS-BROWN EXHIBIT

The E. H. Mumford Co., Elizabeth, N. J., displayed its jolt rock-over draw machine. This machine is designed according to the principles invented by the late E. H. Mumford. An oil-controlled guide plunger is provided, which in combination with an improved starting valve is said to insure a smooth start and a more uniformly accelerated draft.

Further development in automatic sand-blast apparatus was evident in the displays at Boston. Also it is apparent that self-contained sand-blast units are growing in popularity among foundrymen. As a result of legislation and a more enlightened appreciation of the importance of the welfare question, foundrymen today are not content with sand-blast apparatus in which the dust-disposal problem has not been thoroughly worked out. The day has passed, therefore, when sand-blast machinery is purchased piecemeal and operated without attempting to control the dust nuisance.

A 20 x 34-inch gravity-type, positive feed, revolving-barrel sand-blast machine with a capacity of three to five tons of castings a day was displayed by the Brown Specialty Machinery Co., Chicago. In this machine, the sand flows from the main hopper into the auxiliary hoppers and thence to the nozzles by gravity. The air consumption of the machine exhibited is stated to be 75 cubic feet per minute. A larger machine of the same type also is built. It has a 40 x 50-inch barrel, with an air consumption of 300 cubic feet per minute and a rated capacity of 15 to 20 tons of gray-iron or malleable castings a day. The smaller machine is driven by a 2-horsepower motor. The one displayed at Boston has been sold to the government for installation at the Algiers arsenal near New Orleans. The Brown company also displayed its duplex sand sifter and the Hammer core machine.

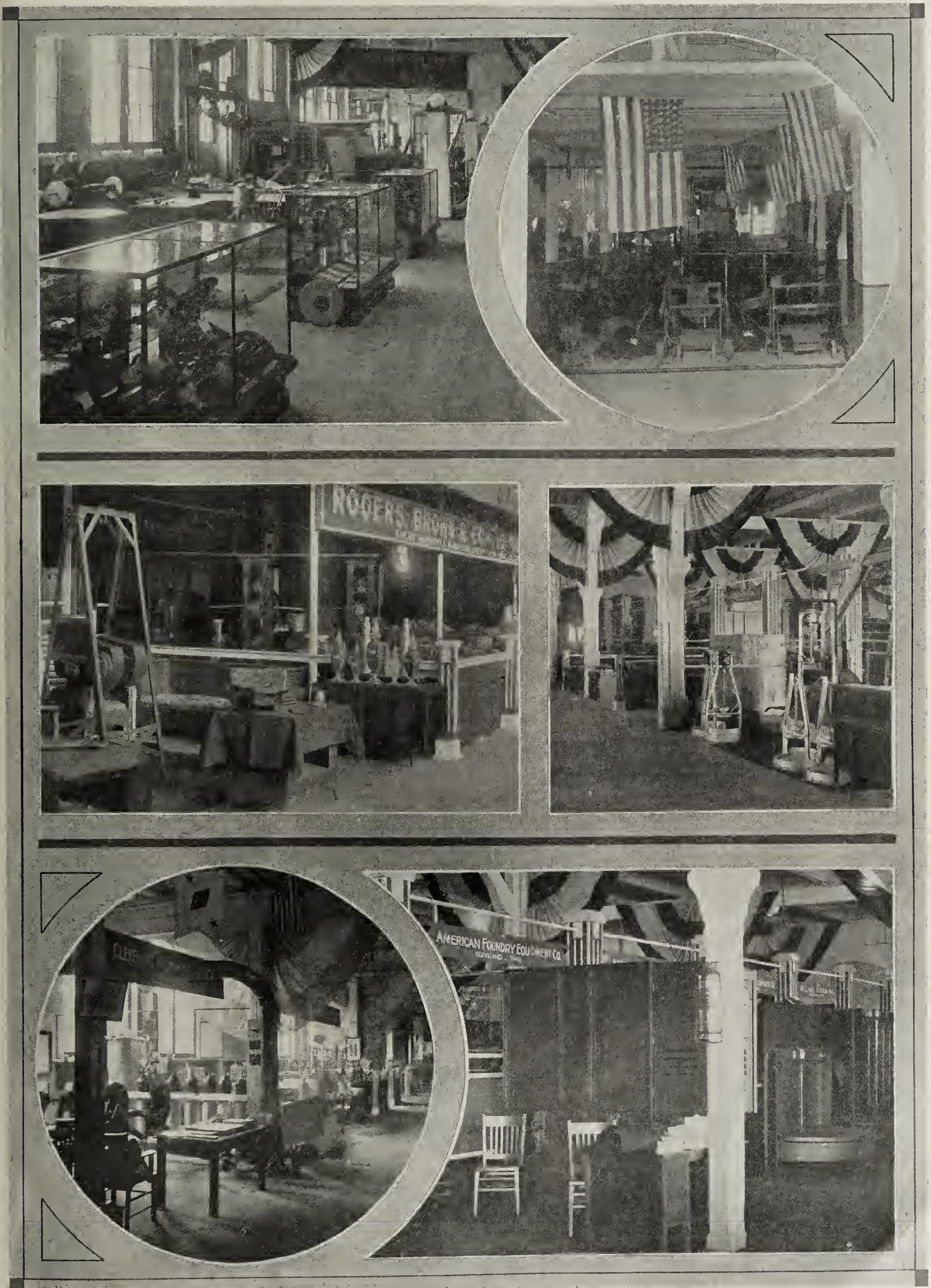
The display of The W. W. Sly Mfg. Co., Cleveland, in the Exhibition Hall, adjoining the Grand Hall, included a complete steel-plate sand-blast room with dust disposal apparatus. This room, which was provided with a closed-hopper sand-blast machine and a grated floor, was approximately 10 x 12 feet in size. A sand-blast barrel with complete dust-handling and sand-renovating auxiliaries also was shown by the Sly company, together with a double unit 6-drawer core oven.

The J. W. Paxson Co., Philadelphia, showed two sizes of its Paxson-Warren sand-blast machine. This machine is designed either for high or low pressure operation. A magnetic separator, a model of a cupola equipped with the Zippler tuyere system and a full line of foundry supplies also were exhibited by the Paxson company.

A sand-blast room of special design in which the operator is said to be practically immune from dust was displayed by the American Foundry Equipment Co., New York. This company also showed several other types of sand-blast machinery, together with its well-known traveling sand-mixing machine.

Improved Rotary Machine

The Hoevel Mfg. Corp., New York, displayed a large sand-blast barrel and an 8-foot rotary table sand-blast machine. These machines were connected to automatic dust-collecting and



THE EXHIBIT COVERED EVERY PHASE OF THE FOUNDRY INDUSTRY sand-renovating units, making them entirely self-contained. The entire exhibit was operated by a 10-horsepower motor.

A large automatic sand-blast barrel and an automatic sand-blast cabinet machine, with dust-collecting and sand-handling units were exhibited in operation by the Mott Sand Blast Mfg. Co., New York.

The National Engineering Co., Chicago, exhibited a 6-foot sand muller operated by a 10-horsepower motor. This machine has a capacity of from 7 to 10 cubic feet per charge. It is said it will mix up a batch of gray-iron facing sand in three to four minutes and a batch of core sand in two to three minutes. The two cast-iron mullers have chilled rims; the plows also are cast iron with chilled surfaces.

Among other exhibitors of sand-blasting, sand-sifting and sand-handling apparatus were The Pangborn Corporation, Hagerstown, Md.; Blystone Mfg. Co., Cambridge Springs, Pa.; Champion Foundry & Machine Co., Chicago; Great Western Mfg. Co., Leavenworth, Kans.; Harrison Supply Co., Boston; J. A. Macleod Co., Cincinnati; and the New Haven Sand Blast Co., New Haven, Conn.

Foundry and sand-blast sands were exhibited by the Portage Silica Co., Youngstown, O., and the Albany Sand & Supply Co., Albany, N. Y. The latter showed a stove made at the Walker & Pratt foundry, Boston, with Albany sand and the former a full line of supplies of silica sand, sand-blast sand, gravel, etc. Foundry sands also were displayed by several of the large dealers in foundry supplies.

Pneumatic Machinery Attractively Displayed

The growing popularity of pneumatic machinery in foundries and machine shops was evidenced by the unusually complete exhibits of manufacturers of air-operated equipment. The Sullivan Machinery Co., Chicago, operated a 14 x 8¾ x 10-inch angle-compound air compressor. This compressor, which is equipped with improved plate valves and driven by a 75-horsepower General Electric motor, delivered air to the various pneumatic tool exhibits. The capacity of the machine is 445 cubic feet of free air against a terminal when operating at 250 revolutions per minute. An 8 x 8-inch belt-driven, pressure of 100 pounds per square inch single-stage compressor of the totally enclosed type was also displayed This exhibit included other pneumatic equipment and a photographic display of machinery made by the Sullivan company.

In addition to a large motor-driven air compressor, which delivered air to some of the pneumatic tool exhibits, the Chicago Pneumatic Tool Co., Chicago, showed a full line of pneumatic hoists, chipping hammers, rammers, drills, grinders, and electric drills, sand shakers, etc. A pneumatic hammer and a drill, with sections cut away to show the valve mechanism in action, were interesting features of this exhibit.

Pneumatic tools and accessories including 250 different pieces of equipment were exhibited in the booth of the Cleveland Pneumatic Tool Co., Cleveland. Sand rammers for floor, flask and bench ramming, chipping hammers, drills and portable grinders were shown in operation. The sand rammers are equipped with exhaust clips which deflect the exhaust air downward into the sand, thus protecting the operator. The portable grinders are designed for wheels from 6 to 10 inches in diameter and operate at from 3000 to 3300 revolutions per minute. Bowes air-hose couplings were also exhibited.

Flag Raising Ceremonies

ON THE stage overlooking the Grand hall of the Mechanics' building during the entire exhibition week floated the national ensigns of the three major allies, England, France and the United States. The American flag, as was appropriate, was on the highest staff in the center. Every morning promptly at 9:30 a file of marines from the Boston navy yard raised the flags with full military honors, while the orchestra played "God Save the King", the "Marsellaise" and the "Star Spangled Banner". A large audience attended this effective ceremony every day. Thus again was the theme of national service emphasized and the unity of the great democracies of the world demonstrated.

A vertical double-cylinder single-acting compressor, water cooled with a regulating sight feed splash oiling system was operated by the Curtis Pneumatic Machinery Co., St. Louis. This compressor supplied air for hoists and trolleys which formed part of the exhibit. A single I-beam hand operated bridge crane with trolley and a single I-beam bracket jib crane were shown. Vertical cylinder air hoists suspended from I-beam trolleys were also exhibited.

Centrifugal air compressors for cupola blowing formed an important part of the exhibit of the General Electric Co., Schenectady, N. Y. One of the compressors was provided with a 50-horsepower alternating-current motor drive and the other with a 20-horsepower direct-current motor drive. The compressors are adapted to motor or turbine drive. The unit driven by the 50-horsepower motor has a capacity of 7200 cubic feet of air per minute. When driven by a direct-current motor, the pressure is regulated by changing the speed of the set by a field rheostat. When driven by an induction motor, the blast is regulated instead of the motor. The core oven exhibit of the General Electric Co., is described elsewhere in this article

Welding and Cutting Apparatus

The exhibits of welding and cutting apparatus for foundry cleaning rooms and for general repair work were unusually interesting because in practically every booth where this type of equipment was displayed, demonstrations of the actual process of cutting or welding were given. The Oxweld Acetylene Co., Newark, N. J., produced acetylene in a generator having an hourly capacity of 50 cubic feet. This gas was used in cutting and welding pipe and other iron and steel articles. The exhibit also included a display of welding and cutting torches, tips, etc.

A large crankshaft welded by the thermit process was exhibited by the Goldschmidt Thermit Co., New York. Pictures of unusual welding jobs were displayed, and pieces of plain, coupled and welded pipe which had been tested for tensile strength, bursting strength and vibration were shown. Samples of carbon-free metals and alloys made by the Goldschmidt company were shown.

The Davis-Bournonville Co., Jersey City, N. J., exhibited various kinds of oxy-acetylene cutting and welding apparatus and accessories. The accurate cutting of plates by an acetylene torch was demonstrated on a machine provided with a table for holding the work and a special holder for the torch. The latter has a pantograph motion which enables the operator to easily control the movement of the torch. Gas used in the cutting and welding apparatus for demonstrating purposes was generated in a generator made by the Davis-Bournonville Co.; it had a capacity of 100 cubic feet of acetylene per hour.

Grinding wheels and abrasive materials were shown by the Carborundum Co., Niagara Falls, N. Y. Divine Bros., Utica, N. Y., displayed a number of compress polishing and buffing wheels, glue for polishing purposes, and cushion wheels for trucks.

Among the companies exhibiting crucibles were the Joseph Dixon Crucible Co., Jersey City, N. J.; New Chicago Crucible Co., Chicago; Foreign Crucible Corp., Ltd., New York; and the O. K. Crucible Co., New York.

The manufacturers of metals and al-

MACHINE TOOLS OF MANY TYPES WERE DISPLAYED IN THE BASEMENT

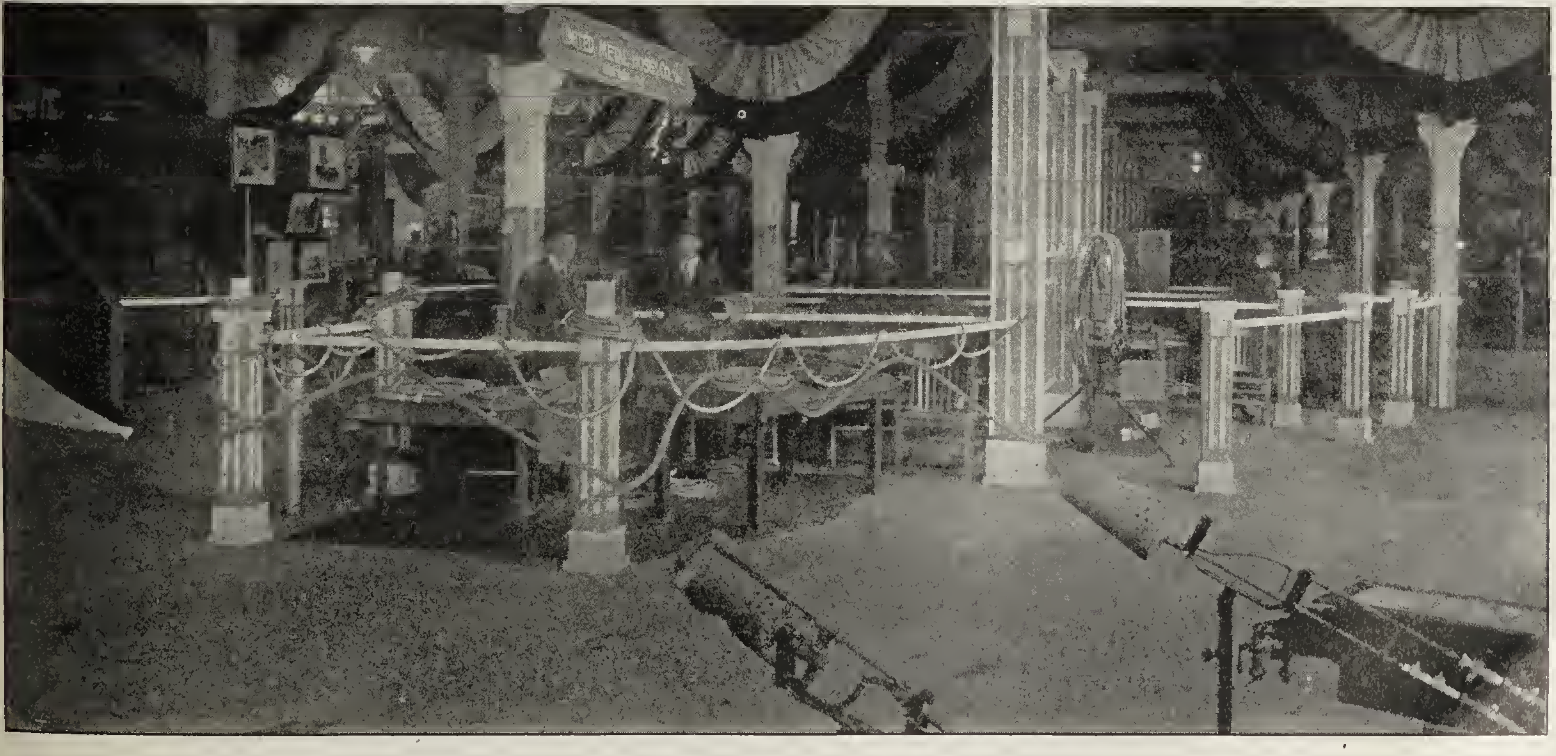
loys used in the foundry industry departed from the usual display of ingots, and arranged interesting exhibits of castings made from their metals. This was especially true of the booth of the Ajax Metal Co., Philadelphia. The castings shown included a submarine-engine base of extra strong manganese bronze, plastic bronze bushings, bearings and boxes for large locomotives, machine-gun castings, railroad-car fittings, fire-engine castings and turbine parts. Ingots of various metals and alloys made by this company were also shown.

Castings made from metals of the Michigan Smelting & Refining Co. were shown. This company also showed ingots of copper, brass, tin, babbitt, special alloys and aluminum. Other exhibitors of metals and alloys who showed ingots and castings were the Eastern Brass & Ingot Corp., Waterbury, Conn., and S. Birkenstein & Sons, Chicago. The Titanium Alloy Mfg. Co., Niagara Falls, N. Y., exhibited ferro-carbon-titanium and castings made by the Titanium Bronze Co., Niagara Falls, N. Y., an allied company.

Attractive Display of Coke

In this year's show, as in those of the past, the exhibits of coke were unusually attractive. The large reproduction of Bunker Hill monument executed in coke made by the New England Coal & Coke Co. stands out as the most elaborate exhibit of the Boston show. This monument, rising nearly to the ceiling of the Grand Hall, was surrounded by four large statues showing typical Puritans in the costume of their time. Colored lights hanging in festoons from the top of the monument and potted plants added to the attractiveness of the exhibit.

The exhibit of Pickands Brown & Co., Chicago, consisting of a large hub made of Solvay coke, attracted considerable attention. Rogers, Brown & Co., Cincinnati, displayed a large number of fine castings made from the various grades of pig iron handled by that company. Samples of many kinds of pig iron, bee-hive and by-product cokes, and ferroalloys were shown. The Debevoise-Anderson Co., Inc., New York, showed samples of coke, pig iron, limestone, coal and 50 per cent ferro-



A GLANCE AT THE EXHIBIT IN EXHIBITION HALL silicon. The Thomas Iron Co., Easton, Pa., showed samples of pig iron, and test bars and typical castings from the iron made by the company.

Many Core Binders Displayed

As usual, the manufacturers of core compounds maintained comfortable booths for visiting foundrymen and displayed cores and castings in which their products were employed. Among the exhibitors of core compounds were the American Gum Products Co., New York; Robeson Process Co., New York; Werner G. Smith Co., Cleveland; Spencer Kellogg & Sons, Inc., Buffalo; Cataract Refining & Mfg. Co., Buffalo; United Compound Co., Buffalo; United States Graphite Co., Saginaw, Mich.; J. S. McCormick Co., Pittsburgh; Corn Products Refining Co., New York.

Core and mold ovens of the car and drawer type, core cars, melting furnaces, oil burners, etc., were shown in the booth of the Foundry Equipment Co., Cleveland. The General Electric Co., Schenectady, N. Y., operated an electric core oven made by the Oven Equipment & Mfg. Co., New Haven, Conn. The oven is equipped with pyrometers made by the Taylor Instrument Co., Rochester, N. Y. Green cores were dried in this furnace throughout the week. The G. S. Blodgett Co., Burlington, Vt., exhibited three types of core baking ovens.

Crucible and non-crucible melting furnaces were shown by the Buckeye Products Co., Cincinnati. The Ludlum Electric Furnace Co., New York, showed a working model of the new Ludlum furnace. Samples of the castings from this furnace and pictures of the furnace in actual operation were displayed. The Monarch Engineering & Mfg. Co., Baltimore, exhibited an unusually complete line of tilting, stationary and portable furnaces for melting metals. In addition to a large variety of miscellaneous foundry equipment, the S. Obermayer Co., Chicago, exhibited a brass melting furnace.

Melting Fire Brick

The Quigley Furnace Specialties Co., New York, demonstrated a high-temperature cement adapted for use in repairing crucibles, lining cupolas and melting furnaces, etc. Brick which had been bonded by the cement was burned in an electric furnace at a heat of about 3200 degrees. Methods of repairing crucibles were shown in pictures.

The General Fire Extinguisher Co., Providence, R. I., exhibited various parts of automatic sprinkling equipment, including the telegraphic equipment for central station alarms. A sprinkler head in a glass covered compartment afforded an opportunity for demonstrating the action of the heads when subjected to the heat of a fire.

Wood blocks for floors were exhibited by Ayer & Lord Tie Co, Chicago, and the Jennison-Wright Co., Toledo, O. Safety equipment including shoes, goggles, clothing, etc., was shown by the Safety First Shoe Co., Providence, R. I.; R. P. Smith & Sons Co., Chicago; Strong, Kennard & Nutt Co., Cleveland; Julius King Optical Co., New York.

Electric hoists for foundries were shown by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. Monorail track, and trolley accessories were also shown. Photographs of hoisting apparatus were displayed by the Hayward Co., New York

Many Machine Tools Shown

An unusually large variety of machinery for machine and pattern shops was displayed at the Boston show. The Gardner Machine Co., Beloit, Wis., exhibited horizontal and vertical disc grinders, several of which were equipped with exhaust systems. A horizontal disc grinder, motor driven and provided with an exhaust blower made by the Buffalo Forge Co., Buffalo, N. Y., attracted considerable attention. Samples of work done on disc grinders were displayed.

Belt and motor-driven grinding and polishing machinery was displayed by the Bridgeport Safety Emery Wheel Co., Bridgeport, Conn. A thread-milling machine and a gear generator built by the Lees-Bradner Co., Cleveland, were exhibited by Lynd-Farquhar Co., Boston, New England representatives of the Lees-Bradner Co.

Four double-spindle grinding machines were shown in operation by the Norton Co., Worcester, Mass. The safety devices attached to these machines were noticeable, the wheels being protected by guards and the belts being screened by box-shaped wire cages. Each machine was equipped with an exhaust system for carrying away the dust. In addition to the grinding machines, a wide variety of wheels for various kinds of grinding work were displayed.

Quick-change drill chucks were demonstrated by the McCrosky Reamer Co., Meadville, Pa. This exhibit also included adjustable and plain reamers, tool posts for lathes, holders for turret lathe tools, and universal lamp brackets for machine tools. Part of this equipment was shown in actual use on drills and lathes.

The Oliver Machinery Co., Grand Rapids, Mich., exhibited a 16-inch toolroom lathe. Pictures of pattern-shop machinery, including a universal wood milling machine were shown. A pipe bending machine equipped with adjustable parts for bending pipe into various intricate shapes was demonstrated by representatives of the American Pipe Bending Machine Co., Boston. Internal grinders, a threading tool and a back-geared precision bench lathe mounted on a cabinet with individua motor-drive and attachments were shown by the Rivett Lathe & Grinder Co., Boston.

Hack saw blades, and frames, hand saws, circular saws, metal cutting machines and core plates were shown by the E. C. Atkins & Co., Indianapolis Ind. The Athol Machine Co., Athol Mass., displayed a large variety of shop tools including calipers, dividers, an vises. The vises are equipped with nonslidable handles, which have ratchet connection with the vise-hea screw, allowing the handle to be swun at any desired handle without disturbing the position of the vise jaws. A feature of the exhibit is a small mode of a meat chopper, the first inventior of L. S. Starrett.

Four power-driven magnetic separators were exhibited by the Dings Magnetic Separator Co., Milwaukee. One of these machines was equipped with motor, another with a motor-generato set and a third with a hand magnet The other separator was of the magneti pulley type with motor.

Other Exhibitors

Among the other exhibitors whos booths attracted attention were Felt & Tarrant Mfg. Co., Chicago; Abell-Howe Co., Chicago; Forbes & Myers, Worcester, Mass.; American Lighting Co. Chicago; Pittsburgh Crushed Steel Co. Pittsburgh; Armstrong Cork Co., Pittsburgh; Asbury Graphite Co., Asbury N. J.; General Plater's Supply Co., New York; Hart & Hutchison, New Britain Conn.; Hauck Mfg. Co., Brooklyn, N Y.; Standard Equipment Co., New Haven, Conn.; Sterling Wheelbarrow Co. West Allis, Wis.; W. F. Stoddard Syracuse, N. Y.; Frank D. Chase, Chicago; Chase Turbine Mfg. Co., Orange Mass.; Lewis-Shepard Co., Boston Chisholm-Moore Mfg. Co., Cleveland United Metal Hose Co., New York David Lupton's Sons Co., Philadelphia Charles J. Clark, Chicago; Clevelan Blow Pipe & Mfg. Co., Cleveland United States Silica Co., Chicago; Maln Mfg. Co., Minneapolis; Malleable Iron Fittings Co., Branford, Conn.; Cleveland-Osborne Mfg. Co., New York Thomas E. Coale Lumber Co., Philadelphia; White & Bros., Inc., Philadelphia McLain's System, Inc., Milwaukee Combined Supply & Equipment Co. Buffalo; Moltrup Steel Products Co. Beaver Falls, Pa.; Cutter & Wood Supply Co., Boston; T. B. Wood's Sons Co., Chambersburg, Pa.; Norma Co. of America, New York; G. Drouve Co. Bridgeport, Conn.

The Effects of Seasoning on Gray Iron Castings

Results of Tests on Cast Iron Surface Plates and Straightedges Subjected to Widely Varying Treatment—Many Problems Still Unsolved

By L M Sherwin

THE term seasoning is a very broad one and numerous definitions can be found covering various methods of procedure, but the one which has the most bearing on this subject is as Webster gives it, namely, "the maturing or the changing from the crude to the more perfect condition; to mature; to grow fit for use." This is what actually happens to gray iron castings when they are subjected to any process tending towards their improvement. The necessity for seasoning is due largely to internal strains and existing stresses arising usually from the design of the casting, or from some unusual condition such as heat and cold being applied to any one particular location on a casting and not to the other sections.

There are several different methods of seasoning castings in vogue at the present time, and it would be difficult indeed to determine without actual experimenting with the various processes just which method would be the more valuable and which one could be recommended the most highly. Individual requirements would be the governing factor in determining the method, and would therefore prevent making a general or definite assertion. Some of the methods being used are as follows:

1.—Castings remaining in one place and position for an indefinite period, and in some cases exposing them to weather conditions, before they are finish-machined.

2.—Castings having been rough-turned or planed, and then subjected to a heat of several hundred degrees, say as high as 400 degrees Fahr., for a definite period of time.

3.—Castings heated from 150 to 300 degrees Fahr., before having the scale removed.

4.—Castings heated and re-heated several times at 400 degrees Fahr.

It is generally recognized that there is some benefit to be derived from some sort of seasoning. It has been found that the castings after receiving this treatment will have a greater tendency toward holding their shape more permanently than those that have not received any treatment, and, as far as is known at the present time about straightedges, surface plates and other castings of a similar nature; the second method is believed to be more preferable and can be recommended for this purpose.

Much has been written about shrinkage, internal strains, external stresses and contraction, and all of these factors have a decided relation to the seasoning process. The shrinkage, both internally and externally, usually is the result of poor designing, but there are many instances where the mixture of the gray iron is entirely at fault, causing these unusual conditions. With a casting so designed that there are several, or even one heavy and one light section, the heaviest portion will naturally be the last to become solid, which indicates that the lighter section on cooling drew the molten metal to that part and in so doing left void places in the heavy sections. The reduction in the various dimensions of a casting, after reaching the solidified state, is known as the contraction. Sometimes the internal shrink is referred to as the *spongy shrink*, and the external shrink as the *sucking in shrink*. The former in many cases is caused by the carbon in the mixture being too high, while the latter is due to too low carbon in the mixture. The above conditions will effect the strains and stresses, and, as these are the governing factors regarding seasoning, every known precaution that is practicable should be observed in order that castings to be seasoned will be sound and be

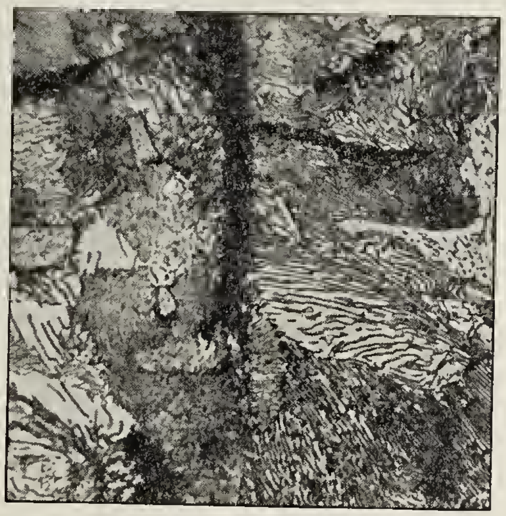


FIG. 1—MICROGRAPH OF TEST BAR *1 A*
Heated at 1100 Degrees Fahr. for 24 Hours—Microstructure Unchanged—Magnified 100 Times

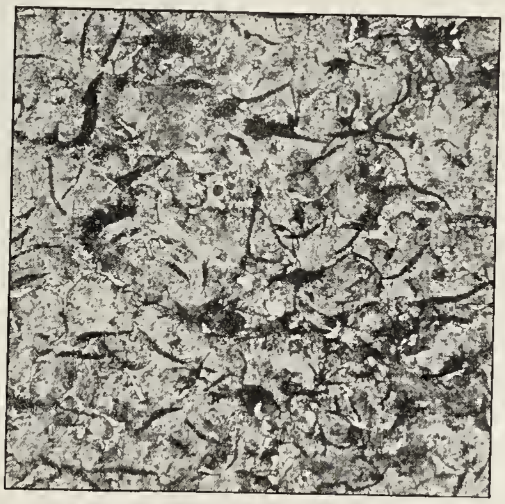


FIG. 2—TEST BAR *1 A*
Magnified 500 Times

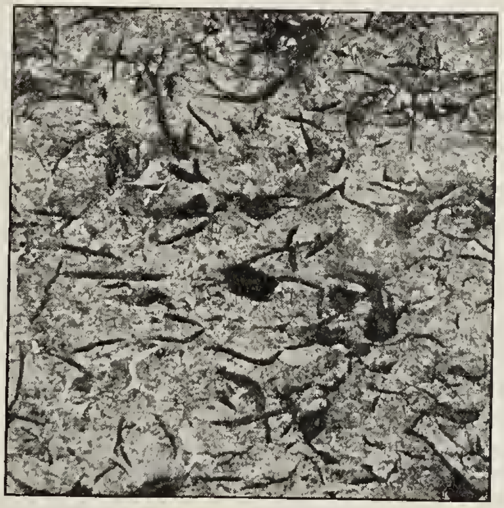


FIG. 3—MICROGRAPH OF TEST BAR *2 A*
Microstructure as Cast—Magnified 100 Times

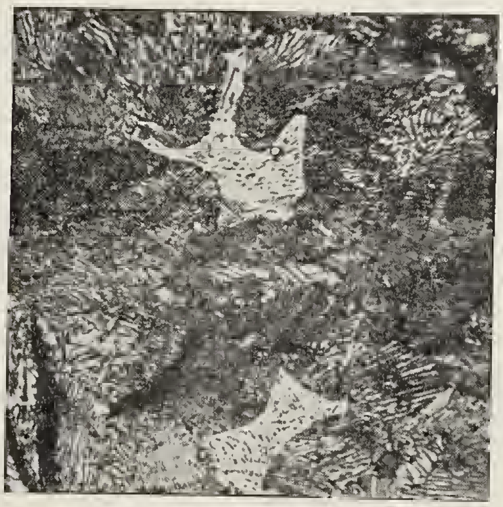


FIG. 4—TEST BAR *2 A*
Magnified 500 Times

A paper presented at the Boston meeting of the American Foundrymen's association. The author, L. M. Sherwin, is associated with the Brown & Sharpe Mfg. Co., Providence, R. I.

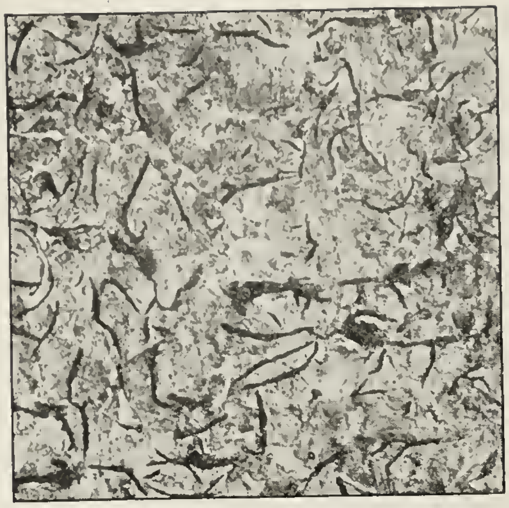


FIG. 5—MICROGRAPH OF TEST BAR *3 A*
Microstructure as Cast—Magnified 100 Times

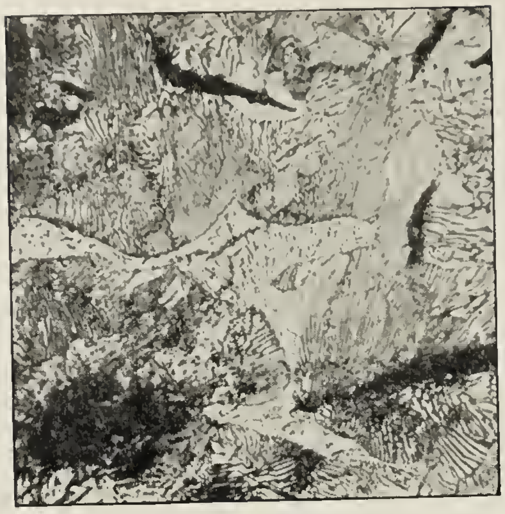


FIG. 6—TEST BAR *3 A*
Magnified 500 Times

of good texture, regardless of the method which is to be used later in seasoning. The casting undergoes expansion and contraction during the process of cooling from the molten state to the solidified condition and after reaching this state the mobility of the molecules will allow for seasoning.

Many interesting experiences and facts have been brought out during the past few years in connection with seasoning and several experiments carried through which have proved more or less successful. At the present time tests and experiments are being conducted with surface plates and straightedges to determine the best and most economical method of handling gray iron castings for these purposes.

Several years ago an elaborate system, consisting of a large box containing coils of steam pipes, was installed. The castings were placed in the box and live steam passed over the castings through the pipes; thus raising the temperature in the box to the desired degree. This system was discarded as being too expensive for the results obtained. The value of this method has always been a more or less debated question.

Various efforts have been made to equalize the strains and stresses. Some of these have been the designing of a surface plate with two parallel faces and a uniform distribution of metal throughout. This particular casting has been in daily use for several years and seems to be giving entire satisfaction. The casting was first rough-planed and then heated. Also there have been castings such as sliding tables designed with several medium and light sections, as well as other castings with all the sections of relatively the same proportions and weight. Experience has proved the uniformly designed table to be less changeable. It is probable that by heating the former castings to some definite degree for several hours their tendency to warp would be materially lessened.

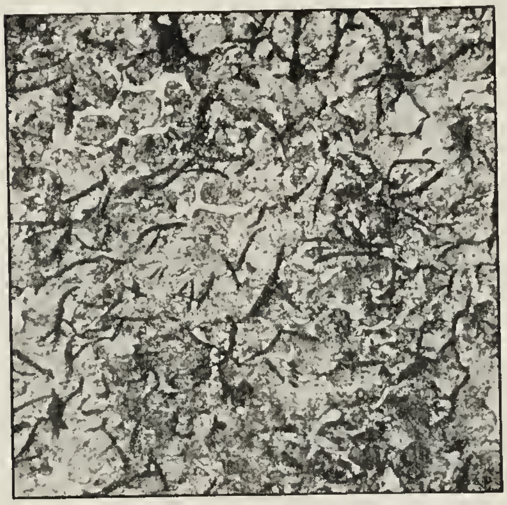


FIG. 9—MICROGRAPH OF TEST BAR *1 A'*
Microstructure as Cast—Magnified 100 Times

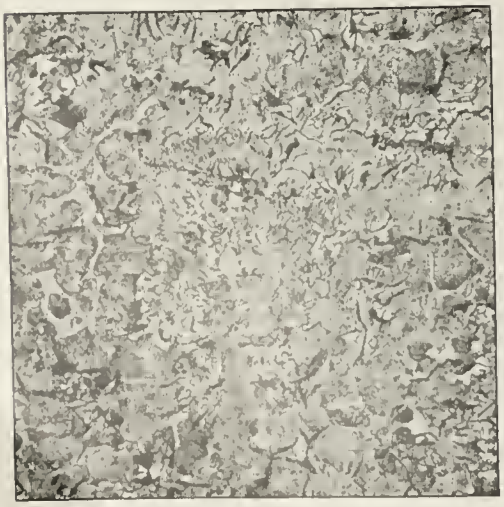


FIG. 7—MICROGRAPH OF TEST BAR *4 A*
Microstructure as Cast—Magnified 100 Times

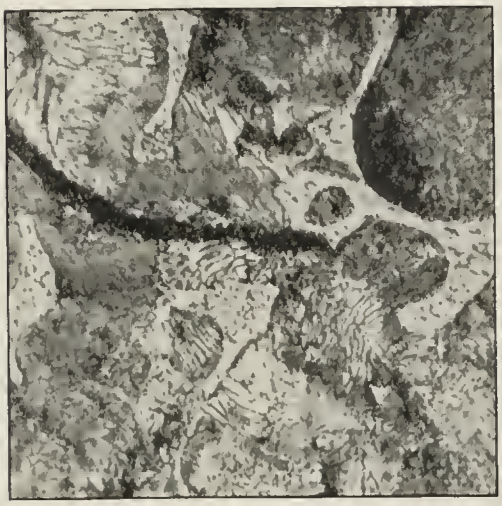


FIG. 8—TEST BAR *4 A*
Magnified 500 Times

Instances where manufacturers have claimed that a certain straightedge had changed its shape during the day have been investigated, and it was found that the room temperatures were affecting the marking (the marking is shown by rubbing the prepared surface against a master plate). The temperature of the room in such cases was about 60 degrees Fahr. Upon raising the temperature to 70 degrees the trouble was entirely eliminated.

It has also been found that the temperature will materially affect the marking of all surface plates and straightedges, and the most satisfactory temperature for working conditions at which the marking and scraping is done is about 70 degrees Fahr. It is almost impossible at the present time, unless under ideal conditions regarding room temperatures, to scrape and mark these castings in one continuous period. Some castings are started and worked on for one-half hour between the hours of 7:00 a. m. and 7:30 a. m., then they are laid aside for two hours and at 9:30 a. m. the scraping is again started and finished. The change under these conditions is no greater than 0.001 inch in a length of 6 feet. In the winter the changes referred to are more perceptible than in the summer, and the long narrow castings show a more noticeable change between the temperature of 60 degrees Fahr. and 70 degrees Fahr. than from 70 degrees Fahr. to 80 degrees Fahr. A difference of 10 degrees makes a change in the marking of approximately 0.001 inch. If a straightedge is marked and scraped at 70 degrees Fahr., then marked again at 85 degrees Fahr., it is

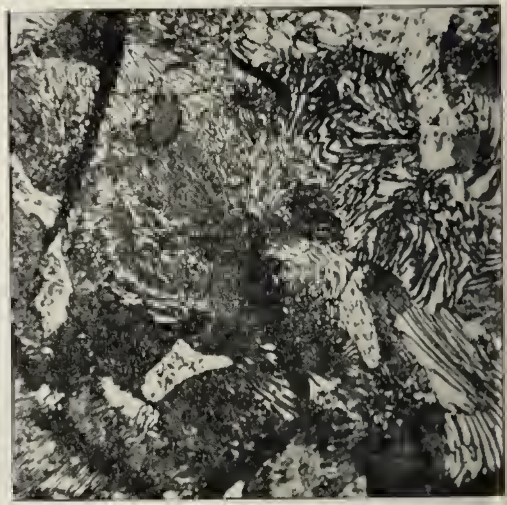


FIG. 10—TEST BAR *1 A'*
Magnified 500 Times

very seldom that any change can be detected. If, on the other hand the castings are marked and scraped at 70 degrees Fahr., to say 60 degrees Fahr., a noticeable change takes place. Of course, where there are heavy and light sections and corresponding strains and stresses, the light sections are more easily affected by the rise and fall of the temperature.

The placing of the bare hand on the center of a straightedge 4 feet long in less than half a minute changes the marking. Consequently, all surface plates and straightedges are fitted with wooden handles to be used by the workman to prevent this change from heat. The sunlight coming through a window and striking such castings quickly changes them.

When working on straightedges, one man has three straightedges, and, if on surface plates, he has two. The trouble is usually encountered in the machining and scraping, and it is a very expensive proposition to refinish these castings after they have been once finished. Therefore, every precaution is taken to make the casting as nearly correct as possible. The best results can be obtained by seasoning.

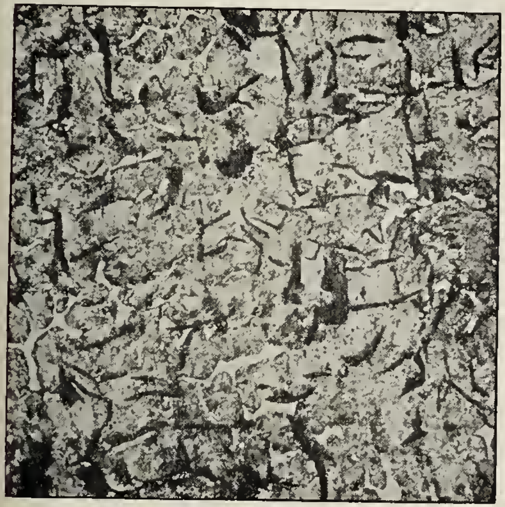


FIG. 11—MICROGRAPH OF TEST BAR *2A'*
Heated at 1100 Degrees Fahr. for a Period of 1 Hour, Three Different Times—Microstructure Unchanged—Magnified 100 Times

Every surface plate and straightedge is first rough-planed and then subjected to a temperature varying from 350 to 550 degrees Fahr., depending entirely on the size, shape and class of the castings. Some castings require 350 degrees, others 400 degrees Fahr., while still others may require 500 degrees Fahr. After heat treating, the castings are finish-machined and then scraped.

It is wrong to assume that after a casting has been seasoned that it will be immune from any changes. Excessive heat and cold will always affect the castings, but after the cause has been removed the castings return to their original shape unless the heat or cold has been so intense that the castings have become warped. In such an event, re-machining is necessary.

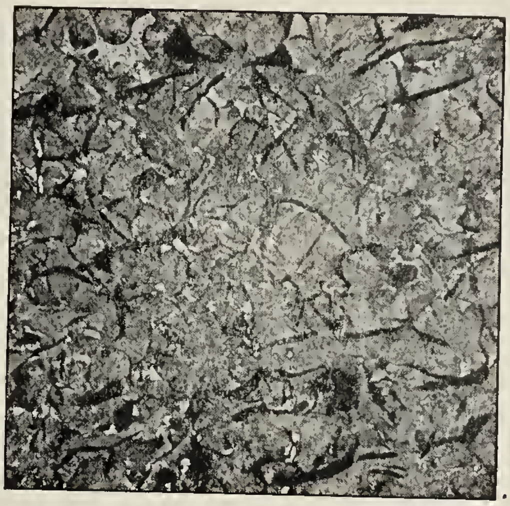


FIG. 13—MICROGRAPH OF TEST BAR *3A'*
Heated at 400 Degrees Fahr. for 16 Hours, Microstructure Unchanged—Magnified 100 Times

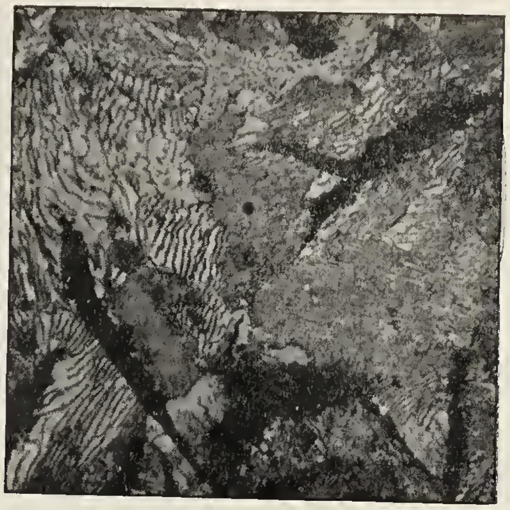


FIG. 14—TEST BAR *3A'*
Magnified 500 Times

Long narrow plates give far more trouble in machining and scraping than square castings. Very little difficulty is experienced with narrow castings of short lengths.

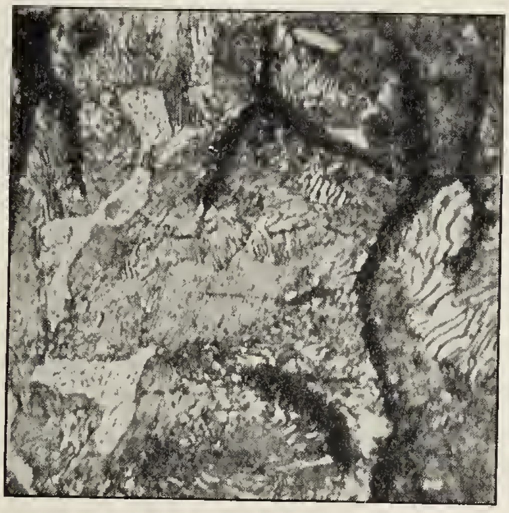


FIG. 12—TEST BAR *2A'*
Heated at 1800 Degrees Fahr. for 24 Hours, Pearlite Completely Decomposed—Microstructure Unchanged—Magnified 500 Times

Castings which have not been heat-treated and are left for a long period of time in the yard exposed to the weather, are found to be seasoned to an extent about equal to that which the castings receive from heat treatment. If unlimited time could be given to castings which need fine finishing and scraping, they could undoubtedly be seasoned as well without heat as with it, but the condition of manufacturing at the present time makes this difficult.

It has been reasoned that if heating to from 300 to 500 degrees Fahr. proves beneficial, why would not a higher temperature be more effective? On the assumption that this theory is correct, we have at the present time various castings undergoing this treatment. The castings have been carried through the various processes up to scraping and marking, and it is to be regretted that more time was not available for the completion of these experiments. To date the results have been fairly satisfactory, but they have not reached the stage where they could be tabulated with any degree of certainty as to their correctness. The relative merits of the plates heated to 400 and 1100 degrees Fahr. are about equal. Before proceeding with these experiments it was

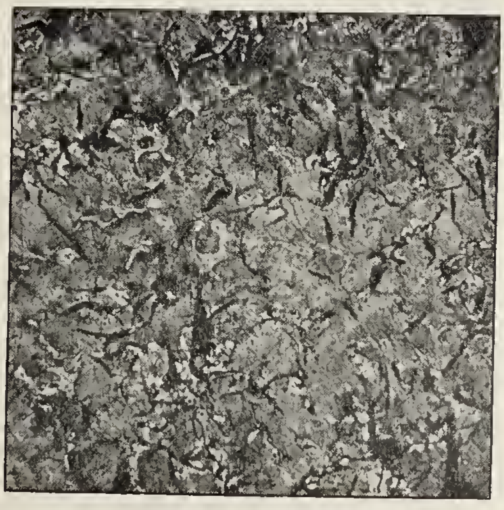


FIG. 15—MICROGRAPH OF TEST BAR *4A'*
Microstructure as Cast—Magnified 100 Times

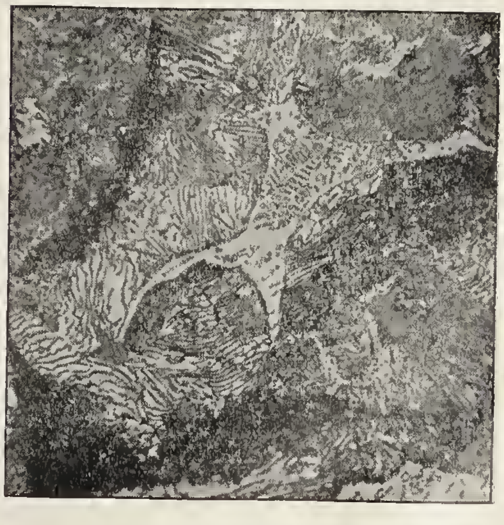


FIG. 16—TEST BAR *4A'*
Magnified 500 Times

Chemical Composition of Test Bars

	1A	1A'	2A	2A'	3A	3A'	4A	4A'
Silicon	1.86	1.87	1.75	1.83	1.91	1.93	1.95	1.97
Sulphur	0.116	0.115	0.118	0.119	0.080	0.075	0.081	0.078
Manganese	0.56	0.52	0.54	0.51	0.51	0.53	0.51	0.53
Phosphorus	0.49	0.42	0.44	0.41	0.49	0.45	0.48	0.47
Combined carbon	0.73	0.69	0.71	0.65	0.79	0.67	0.68	0.64
Graphitic carbon	2.47	2.47	2.47	2.51	2.57	2.61	2.77	2.75

TENSILE TESTS		SCLEROSCOPE TEST		BRINELL TESTS	
Bar	Pounds per square inch	Bar	Number	Bar	Number
1A	37,200	1A	36	1A	207
2A	37,000	2A	34	2A	207
3A	36,300	3A	33	3A	187
4A	34,300	4A	36	4A	183
1A'	36,900	1A'	35	1A'	192
2A'	35,100	2A'	35	2A'	196
3A'	36,000	3A'	33	3A'	187
4A'	35,400	4A'	37	4A'	196

absolutely necessary to determine what temperature would be a safe maximum to adopt for the treatment of the castings when considering the wearing qualities, shape, etc. The transformation range for cast iron of this grade is between 1250 and 1375 degrees Fahr. This means that when heated above the latter temperature the combined carbon, structurally termed pearlite, is changed slowly into its elements, namely, iron and carbon. Later at a higher temperature the graphite increases the size of the previously formed graphite.

Carefully conducted experiments with this iron to obtain heating and cooling curves resulted in establishing the arresting point on cooling at 1330 degrees Fahr. A long period of heating at a temperature below this range, namely, 1100 degrees Fahr., should not affect the microstructure of any component. To verify these premises was one of the objects of the heat-treating experiments.

Twenty castings were used in these experiments and were cast at approximately the same time in the heat and under the same conditions, such as rapidity of pouring and temperature of the metal. The castings were all removed from the sand at about the same time and were given an equal chance for cooling. All were rough-planed and some of them subjected to various heats while others did not undergo the heat treatment.

The castings used in the experiments were four straightedges, 1⅞ x 36 inches; six straightedges, 2 x 48 inches; four surface plates, 24 x 48 inches; and six surface plates, 6 x 26 inches. A set of two test bars were cast with the same mixture and at the same time as were each of the four 24 x 48-inch surface plates, and marked 1A, 1A', 2A, 2A', 3A, 3A', 4A, and 4A'. The bars, 1A, 2A, 3A and 4A were tested as cast. Bars 1A', 2A', and 3A' were tested after being heated as follows:

1A' heated to 400 degrees Fahr. for a duration of 24 hours.
2A' heated to 1100 degrees Fahr. for a duration of 24 hours.
3A' heated to 1100 degrees Fahr. on three different occasions and cooled in each case.

The bar 4A' was tested as cast. In each case the bars A and A' were cast at the same time and in the same mold.

Another test bar, B, cast of the same quality iron, was then heated to 1800 degrees Fahr., but the micrograph proves the method to be undesirable.

It was desired to ascertain, if possible, the differences in the chemical composition and physical condition between the bars as they were cast and after being heated to various temperatures. The four 1⅞ x 36-inch straightedges were treated as follows:

1.—Heated to 400 degrees Fahr. for a duration of 24 hours.
2.—Heated to 400 degrees Fahr. for a duration of 72 hours.
3.—Heated to 400 degrees Fahr. for a duration of 168 hours.
4.—No heat.

The 2 x 48-inch straightedges were treated as follows:

1.—Heated to 350 degrees Fahr. for a duration of 24 hours.
2.—Heated to 350 degrees Fahr. for a duration of 48 hours.
3.—Heated to 350 degrees Fahr. for a dura- of 72 hours.
4.—Heated to 1100 degrees Fahr. for a duration of 24 hours.
5.—Heated to 1100 degrees Fahr. three different times and cooled in each case.
6.—No heat.

The 6 x 26-inch surface plates were treated as follows:

1.—Heated to 400 degrees Fahr. for a duration of 24 hours.
2.—Heated to 1100 degrees Fahr. for a duration of 24 hours.
3.—Heated to 1100 degrees Fahr. on three different occasions and cooled in each case.
4.—Heated and re-heated several times at 400 degrees Fahr.
5.—Placed in yard for an indefinite length of time.
6.—No heat.

The 24 x 48-inch surface plates were treated as follows:

1.—Heated to 400 degrees Fahr. for a duration of 24 hours.
2.—Heated to 1100 degrees Fahr. for a duration of 24 hours.
3.—Heated to 1100 degrees Fahr. on three different occasions and cooled in each case.
4.—No heat.

The chemical analyses of the test bars and the results of physical tests are shown in the accompanying table.

In my estimation the subject of seasoning gray iron castings has never received the amount of attention it justly deserves, and, as this work covers individual requirements, the subject has been approached from experiences within our field of endeavor and which have come under our observation.

The following questions have been asked and up to the present time the writer feels that the answers are still a matter of personal opinion and still remain in doubt. Therefore the questions cannot be answered fully and correctly. The questions are:

1.—What are the actual relations of seasoning to internal and external stresses and strains?

2.—Will the chemical composition have a direct bearing on results for castings to be seasoned?

3.—What is the quickest and most accurate way of determining whether the castings are stressed; and, if such is the case, what is the most effective way of realizing the value of these stresses?

4.—What is the best method of seasoning to determine which process would be of the greatest value and at the same time the most economical?

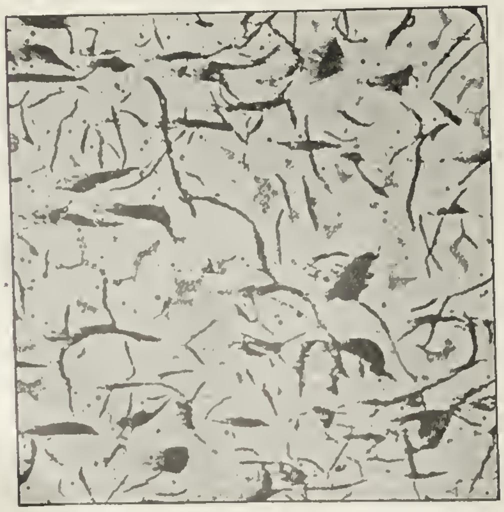


FIG. 17—MICROGRAPH OF TEST BAR B
Heated at 1800 Degrees Fahr. for 24 Hours—Pearlite Completely Decomposed—Graphite Flakes Larger—Phosphide Structure Altered—Magnified 100 Times

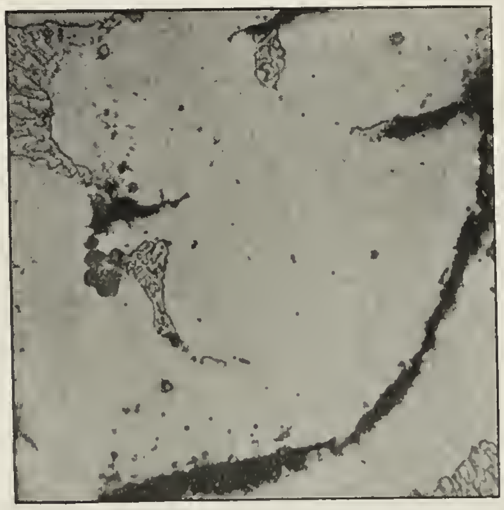


FIG. 18—TEST BAR B
Magnified 500 Times

Making Cast Iron Shells in Permanent Molds

Advantages of Cast Iron and Steel Shells Compared—How Difficulties in Molding May Be Overcome—German and French Practice

By Edgar Allen Custer

THE present conflict has brought about wonderful changes in the generally accepted ideas of warfare. The terrible curtain of fire has made its appearance, earthworks and trenches have been substituted for elaborate and costly fortifications and the aeroplane and submarine have profoundly influenced the strategy on land and sea. In the trenches, old-time stink pots and grenades are being thrown by the ancient catapult, bombs are shot from a contrivance that closely resembles a home-made Fourth-of-July cannon and the form of slingshot that David used on Goliath, has been modernized to a wonderfully effective point. Now we have the spectacle of an unheard of number of rapid-fire, high-caliber guns raining upon the enemy, myriads of cast-iron shells. The continued use of these apparently grotesque contrivances and the revival of cast-iron shells rests on the fact that they have been found to be the most effective means for doing the work in hand.

Cast-Iron Shells Not New

There is nothing new in the use of cast-iron projectiles—before the age of steel they were the sole means of battering down defenses and attacking at long range. Some of the reasons why the use of cast-iron shells was abandoned are that the metal has never had a very good reputation for uniformity and freedom from sponginess and gas holes; its tensile strength is low and it lacks toughness. Any of the defects commonly found in cast iron will seriously affect the trajectory and direction of a shell and render it comparatively useless. It must be absolutely reliable and land at the point at which it was aimed. If one portion is spongy and hence lighter, it will wobble in flight and its main purpose will be destroyed. The weakening effect of sponginess or blowholes may cause the shell to break under the shock of the initial explosion and destroy the gun. A forged steel projectile meets all these objections and has the call.

The objection to steel projectiles is that they are comparatively ineffective against earthworks or trenches when the caliber is 5 inches or less. The amount of contained explosive is small and a great proportion of the explosive effect is used in bursting the walls of the shell. In larger sizes this objection is less apparent. The explosive effect increases with the added charge in a greater ratio than the strength of the added amount of metal in the projectile. The present war has taught us that steel, concrete and brickwork offer but little resistance to modern seige guns and they have been abandoned for earthworks manned with an ample force. The burden of attacking must and does rest with the artillery and the army that is equipped with the most effective guns using the most effective projectiles, will win the most battles. The projectile that is most efficient against earthworks and covers its zone of dispersion with the greatest number of fragments of the proper size is the projectile that will surely be used. It only remains to make that projectile so that it not only will be strong enough to resist the propelling explosion, but also will be perfectly sound and uniform in texture.

During the Spanish-American war, when our fleet was off Santiago, it was observed that one vessel was creating great havoc in the earthworks guarding the entrance, and upon investigation, it was found that this vessel was using loaded practice shells. These shells would tear great holes in the works, while the steel shells were comparatively ineffective. As the vessel had quite a number of these shells in stock, it became very popular with the other ships. A few years ago, some experiments were made on the lower Chesapeake to determine the effect of cast-iron shells on the superstructure of a condemned war vessel. One shell that penetrated the structure and burst in a wardroom was particularly observed. The room was about 20 x 60 feet and one side was lined with lockers. Every locker was torn to pieces and the paint on the walls and ceiling in the line of the explosive force was cut off as with a sand blast. It was the unanimous opinion that the explosion would have killed every man who happened to be in the room at that time. A few tentative experiments were made after this and a permanent mold was constructed, but the project was allowed to drop and no effort was made to thoroughly investigate the subject.

The first intimation we had that cast-iron shells were being used in the present war, was an article in the *London Engineer,* which described a number of fragments of cast iron that were undoubtedly portions of an exploded shell. It was noted that some of the pieces were slightly chilled on one side and the *Engineer* surmised that cast-iron cores were being used. As the peculiarly destructive effect of these shells was observed not only in the open, but also against earthworks, the idea that the Germans were using cast-iron shells on account of the scarcity of steel was abandoned. As a matter of fact, as early as May, 1913, German and Italian munition makers were discussing this phase of projectile work and were seeking all the information that was available. In August, 1913, it was reported to the writer that shells had been made that were satisfactory in that they had the proper degree of fragmentation and were strong enough to resist the effect of the propelling charge. Moreover, these shells were made in iron molds with iron cores.

Theory of the Cast-Iron Shell

The theory of the cast-iron shell is that, when used against earthworks, the greater part of the explosive force is not expended in bursting the walls of the shell and the effect is as if that amount of explosive were detonated in the earthwork. When used in the open, the great fragmentation of cast iron will allow the shell to burst into a far greater number of pieces than a steel shell and will cover the zone of dispersion very closely. It is essential for the work that the degrees of fragmentation be calculated to a nicety. Too great fragmentation will make the shell ineffective. A steel shell weighing 13½ pounds, when charged with one pound of TNT, will burst into approximately 1050 pieces if there is complete detonation. The largest pieces average 0.3 to 0.4 pound in weight and many of these are splinters due to the fibrous nature of the metal. The fragments recoverable have a wide variation in weight, as shown by the fact that while the average weight of the large fragments is almost half a pound, the average weight of all the fragments is

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A paper presented at the twenty-second annual meeting of the American Foundrymen's association at Boston, Sept. 25-28, 1917. The author, Edgar Allen Custer, Philadelphia, is an engineer who has specialized on making castings in permanent molds for over a decade.

about 0.01 pound. It follows that a very large per cent of the fragments would do no harm or at least would not disable except at very close quarters. A cast-iron shell under the same conditions would burst into nearly 1500 pieces with the fragments comparatively uniform in size and weight. It has been found that wide differences in the fragmentation of steel shells have been caused sometimes by the incomplete detonation due to the primer failing to function properly. This is not so serious with the weaker cast iron, but serves to emphasize the fact that a large proportion of the explosive force is expended in bursting the steel walls.

Target shells have been made of cast iron for many years and almost any foundry can make them. It is only essential that the casting be solid and capable of being machined to the proper sizes. The weight of the bursting charge is made up by thickening the walls. If it is not up to weight, a little sand is poured into the cavity. When it comes to making a projectile of cast iron that is to be used against an enemy, a number of difficulties are set up. It must be very strong, it must be easily machined, it must be absolutely solid and free from spongy spots and blowholes, and above all, every shell must have exactly the same degree of toughness. To meet these requirements, the foundry must be run on a strictly scientific basis. There can be no guess work or slipshod methods. When shells are cast in sand, the elements of carbon, silicon and manganese must be held to very definite limits, and these limits vary with the thickness of the shell walls. Moreover, these limits can only be determined by trial. The point aimed at is the correct degree of fragmentation and all foundry methods must be carried out with this point in view. Dry-sand molds, open and porous; perfect cores and trap or swirling gates must be used. The foundry requirements for this work have been ably set forth in an article by Edgar A. Custer Jr., in the April, 1917 issue of THE FOUNDRY and the methods of melting and care of iron and fuel described must be carried out whether the shells are made in sand or in a permanent mold.

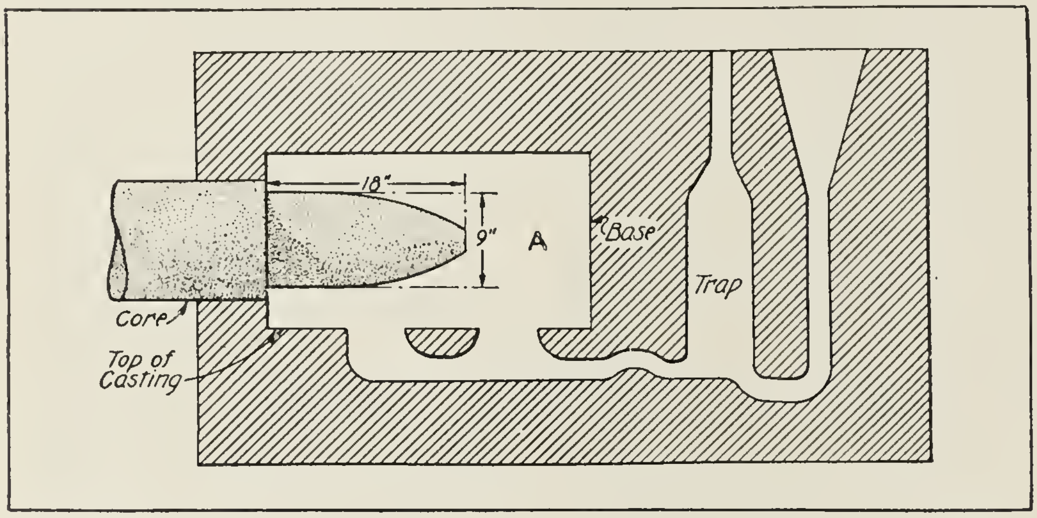

FIG. 1—TWO-PART CAST-IRON MOLD OF SHELL BUSHING WITH 15 INCHES OF METAL SURROUNDING GATES, RUNNERS AND CASTING

Ordinary foundry iron when properly cast in a permanent mold and when removed at the proper time, has, in the resultant casting, the same degree of hardness irrespective of any variation in the chemical constituents, so long as the same size, weight and shape of casting is made. The time the casting remains in the mold is the determining factor of the degree of hardness. A casting weighing about 60 pounds remains in the mold four or five seconds, while a casting of the same general contour weighing 500 pounds will require from 25 to 60 seconds before it is safe to lift it out. To illustrate this point, data on a casting weighing 1100 pounds is presented. Fig. 1 shows the general outline of a mold that was used to make a shell bushing. It will be seen that a trap gate was used and that the casting had a very heavy base and comparatively thin upper walls. In fact, about 65 per cent of the total weight was concentrated in the lower third of the casting. This large mass of metal increased the time interval in that it was necessary to set the walls deeper than in a casting of smaller bulk. There were no risers and the only means provided for the escape of air from the matrix were a few shallow channels cut into the mold at the top of the casting. A large cast iron core operated by a hydraulic cylinder formed the interior cavity. The mold was opened and closed by a similar cylinder. Into this mold irons of the following analyses, all of which were melted in ordinary cupolas, were poured:

	Mixture			
	No. 1 Per cent	No. 2 Per cent	No. 3 Per cent	No. 4 Per cent
Manganese	1.50	0.50	0.80	1.50
Sulphur	0.03	0.05	0.06	0.03
Silicon	1.05	1.75	2.25	1.05
Phosphorus	0.05	0.06	0.06	0.05
Steel scrap.....	....	....	....	16.00

From 10 to 12 castings were poured from each of these irons and when the castings were broken, not one showed the least sign of sponginess or gas holes. The mold was poured full and the first part to freeze was the entrance gate so that there was no possibility of feeding. Only enough iron was poured to fill the cavity.

The time of setting was measured by the time the core remained in the casting before it was safe to draw it. No. 1 iron required 1 minute and 20 seconds before the core was drawn. When the core was allowed to remain in the casting 1 minute and 30 seconds, it was gripped by the iron and had to be cooled to room temperature before removal was possible. No. 2 iron rerequired 1 minute, and No. 3, 30 seconds. In No. 4 a new condition was set up when 16 per cent of scrap steel was melted with the charge in the cupola. In this case it was 2 minutes and 20 seconds before the core could be withdrawn. The results show that in a casting of this size, the low silicon iron cools much slower than one of higher silicon content. The effect of the long time in the mold was to make the casting very hard and heat treatment was given to bring it to machinability. The temperature of the core had no effect on the time of setting, the tenth casting was given the same time as the first, although the core was heated to a temperature of over 400 degrees Fahr.

Mold for a Sixty-Pound Shell

A mold was made for a shell that, when finished, weighed 60 pounds. The mold was made in three parts, as shown in Fig. 2, and was equipped with a cast-iron core. It will be seen that the portion of the shell forward of the bourlette band is cast in the solid part of the mold and no provision is made for venting. The parting of the movable portions of the mold runs in a straight line through the center of the shell and extends 3 inches beyond the base. It then turns at an angle of 45 degrees and runs straight the remaining distance to the outside of the mold. The pouring cup is placed about 5 inches from the outer end of the parting and the main sprue runs down to an easy curve to the bottom of the trap. The entrance to the trap is ¾-inch in diameter, while the main sprue is 1½ inches in diameter. The trap gate is 5 x 4 inches with heavy filleted corners and open at the top. The sides are given ⅛-inch draft, so that the moving parts of the mold will open readily. The bottom of the trap is set low enough to allow a slight hump to be placed in the runner between the trap and the matrix. This hump serves to catch any air or dirt that may be carried with the first rush of the metal.

The center line of the runner is 3 inches below the bottom of the matrix and two gates are cut—one between the revolving band and the base and the other between the band and the bourlette. The gates are 1/16-inch wide and have a small fillet where they enter the matrix. The mechanism for drawing the core is attached to the part *A* and moves with it. Channels are cut in *A* and *B* in the proper position to receive the copper band. The operation of casting is as follows: The copper band is placed in the channels, the mold closed and then poured as fast as the runner will take the metal, keeping the pouring cup full until the end. In four seconds the core is withdrawn, the mold opened and the casting removed. The copper band will be firmly cast into place.

How Castings Are Toughened

It was found that a mixture corresponding to No. 4 in the experiment previously mentioned, with the exception that the manganese was under 0.08 per cent, gave the casting the toughness necessary for the proper degree of fragmentation, but the long exposure in the mold made the casting too hard. A scleroscope reading of 65 to 70 was the invariable result irrespective of any difference in the mixtures. It was evident that some form of heat treatment was necessary to bring the casting to a workable condition. It had been determined that a mark of 45 would give the proper degree of fragmentation. Quite a number of trials were made before it was found that a "flash" heat of 865 degrees Cent. would restore the casting to a good workable condition and bring the scleroscope to just about the correct figure. It was further found that the castings should be allowed to cool before being subjected to the treatment so that a number of shells could be treated at the same time, starting at the same basis of temperature. If the heating furnace has sufficient heat capacity, it requires about 20 minutes to bring the castings to the right temperature and they are then allowed to cool free from drafts.

In a permanent mold, it is impossible to get a casting free from gas or air holes without the use of trap gates. There is no trouble in filling the mold when semisteel is used. The metal does not need to be poured especially fast. Nevertheless, unless a substantial trap gate is provided, small holes will collect against the bottom of the core and the top of the casting. The most careful pouring will not change this condition. There is a point when semisteel can be poured in a permanent mold without these holes forming and without trap gates, and that point is when the metal has cooled until it is almost viscid. The difficulty of successfully hitting this point is so great as to make this method beyond the range of commercial success.

The difficulties that lie in the way of making a cast-iron projectile in sand have been set forth. Some of these troubles may be avoided by the use of a permanent mold. The selection of different irons for different sizes of shells is not necessary. To explain this, one must take into account the fact that the influence of silicon and manganese is exerted only when the molten metal is cooling in the mold and the total effect of this influence is measured by the time the molten metal takes to become solid.

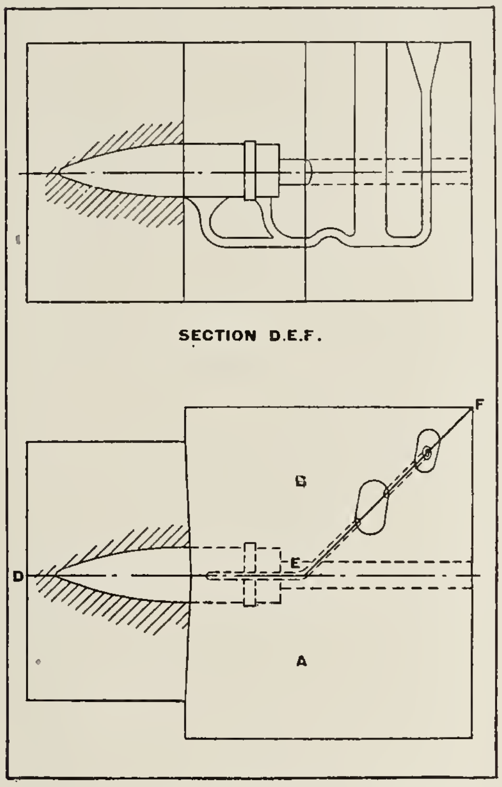

FIG. 2—SKETCH OF THREE-PART PERMANENT MOLD FOR A 60-POUND SHELL

In a sand cast projectile weighing 65 pounds, the time is five minutes, in a permanent mold casting the time is five seconds. The softening effect of silicon is due to its property of forming graphitis carbon—in itself silicon is a hardener. A casting with no carbon and high in silicon would be hard as glass. It requires a certain amount of time to form the graphite flakes and if this time is reduced to a minimum, the formation of these flakes will be prevented. Graphitic carbon will be present, but it will be in such a finely divided state as to be practically amorphous. It resembles the temper carbon of a malleable casting, but is uniformly distributed throughout the structure. Now if the time of setting is so short as to prevent the formation of graphitic flakes, it must follow that under these conditions, silicon has no softening effect. The same statement may be said as to the effect of manganese. A moderate amount of manganese will add strength to a sand casting and is a valuable constituent for a great variety of work. In a permanent mold casting the effect is to make the casting hard and brittle.

When cast-iron shells are used in the open, the fragmentation must be exact, but when used against earthworks, only the explosive force counts. Since it is impossible to set aside shells for each duty, it is obvious that the degree of fragmentation must govern the process. This is easier to accomplish with a permanent mold than by any other known process. As has been said, the question of hardness does not depend upon the variations of the pig iron so long as ordinary foundry iron is used. The same statement is true of the so-called semisteel so long as the same percentage of steel scrap is melted with the iron. The term "ordinary foundry iron" is used to denote pig iron ranging from 1.75 to 2.75 per cent silicon, below 0.80 per cent manganese and with sulphur below 0.08 per cent. Phosphorus has no appreciable effect up to 1.00 per cent. A casting that would analyze 3.00 per cent total carbon, 1.00 to 1.20 per cent silicon, 0.06 per cent manganese, 0.05 per cent sulphur and 16 per cent steel scrap would be an ideal composition for a 60-pound shell. All shells whether cast-iron or steel, must be subjected to a definite heat treatment and, in the case of cast-iron, the degree of heat and time of exposure to get the proper scleroscope test, can be determined only by experiment.

The Design of the Mold

Now a word about the design of the mold. The main point to be considered is that plenty of metal should surround not only the matrix, but also the sprues and runners. In a casting such as a 5-inch shell, there should be at least 10 inches of metal outside of every portion of the mold that comes in contact with the molten metal. The purpose of this is twofold, to provide a sufficient heat storage capacity so that the molten metal will be robbed of its heat in the shortest possible time and to make the mold strong enough to resist the tremendous expansive power of the cooling metal. The matrix and the core should be made to the exact size of the casting before finishing. Make no allowance for shrinkage. Why there is no apparent shrinkage when these castings are made in a permanent mold is a moot subject. It may be that since the interior of the casting is molten when it is taken from the mold and the outside contraction has not started at the time of removal, that the expansive force of the cooling interior metal will neutralize the contracting force of the cooling exterior. It is a very interesting point, but it is true that when the casting is so thick that the interior is molten at the time of removal, shrinkage may be safely ignored.

Mold Should Open Easily

As a further item of design, the mold should be so equipped as to be easily and quickly opened and closed. The movable portions should run on grooved wheels fitting V-shaped tracks. The purpose of this is to prevent small particles of iron interfering with the adjustment of the moving parts. Casting is apt to be a sloppy proceeding and there are always small particles of iron splashing around. Mount the molds so that there is plenty of space underneath to collect any molten metal that may carelessly escape. Before closing the mold, run a flat scraper over the face to remove any small particles that may adhere. If these general rules are followed out, two 60-pound shells can be cast every minute and all will be of the same weight, size and texture.

There is one very important point in the manufacture of cast-iron shells that must be considered and that is the position of the copper revolving band. In some steel shells this band is placed within a very short distance of the base, but in a cast-iron shell, plenty of metal must back up the band. Even with the strength that steel gives, portions of the base are sometimes torn off by the tremendous force set up when the band enters the rifling at a very high velocity. The effect of this rupture is to disturb the trajectory and direction to such an extent as to render the shell not only useless, but dangerous. When the guns are behind the line, pieces of the band, base and even the projectiles may fall into friendly ranks with disastrous results. In a 5-inch shell, the distance between the band and the base must be at least 2½ inches and the band must be sunk into the body of the shell only sufficiently deep to hold it in position. If this point is not observed, the cast-iron shell will be a failure.

When the large projectiles are cast, there is a tendency to form wrinkles on the exterior and interior of the casting due to the surge of the metal while pouring. This is an annoying feature, but the remedy is to make the main runner, where it enters the trap, the controlling factor. If the diameter at that point be kept so small that the main runner can be kept full of molten metal during the entire pouring, these wrinkles will not be in evidence.

The question arises as to the use of steel in permanent molds for the purpose of making shells. The added strength of this metal and the ease with which it can be brought to specifications in the open hearth, is certainly attractive. There is no doubt as to the suitability of steel for this work and it will readily pour in a permanent mold. Moreover, it is not hardened or weakened by the action of the mold. The grain is very fine and it yields exceptionally well to heat treatment. The main difficulty is that the process of casting in a permanent mold is a continuous performance, while the melting of steel in an open hearth is more or less intermittent. The steel when it comes from the open hearth must be poured without delay and after the metal in the ladle is poured, there must elapse an interval of hours before the next heat is ready. Furthermore, the economical melting of steel demands that it be made in furnaces of large tonnage and to pour this tonnage within the time limit within which the steel remains sufficiently molten to work, would require an immense number of molds and an elaborate and costly equipment to handle the ladles, operate the molds and take care of the castings. If the melting of steel can be economically accomplished, so that a continuous supply of molten metal is available, then the manifest advantage of steel over cast iron can be utilized.

When steel is cast in a permanent mold, an allowance must be made for shrinkage, as there is not the same initial expansion as is the case with cast iron. A greater bulk of mold must be provided to take care of the higher temperature and the gates, trap and runners must be given a coating of heavy clay wash after each pouring. This is necessary to prevent cutting the mold. A very slight under cut will put the mold out of business until repairs can be made. Once the "sting" of the molten metal is taken away by the runners, gates and trap, steel will do no harm to the matrix.

French Specifications

The French government has issued specifications for shells cast in sand that are here given in part. They call for the analysis of shells of 122 to 155 millimeters caliber. The chemical analysis is as follows:

	Per cent
Graphitic carbon	0.70
Combined carbon	2.40
Silicon	1.35
Manganese	0.70

The amount of total carbon and silicon must not exceed 4.7 per cent. If this limit is exceeded, the iron will lack toughness. At least 2 per cent of the total carbon must be combined to produce proper fragmentation. The percentage of dust increases as the combined carbon decreases.

Although the sum of total carbon plus silicon is set at 4.7 per cent, it is preferable to keep these limits to 4.4 per cent with a minimum percentage of silicon. The percentage of silicon varies according to the type of molding. In the 122-caliber the best results were obtained by using a minimum of 1.20 per cent silicon for dry sand and 1.35 per cent for green sand. The percentage of silicon varies in inverse ratio to the thickness of the walls and the caliber, the thicker the wall, and higher the caliber, the lower the silicon. Manganese decreases with the thickness of the walls and caliber and increases with the sulphur.

The sulphur should never exceed 0.08 per cent and should be lower whenever possible. The percentage of phosphorus is set at 0.15 per cent or under. The charge should be as follows:

	Per cent
Pig iron	40
Scrap	40
Steel	20

The term scrap is used to denote scrap melted, pigged and charged according to analysis.

These specifications correspond closely to the iron previously mentioned as being ideal for use in permanent molds. The striking point in the specifications is that the silicon decreases when a dry-sand mold is used, and this point is emphasized by the use of a still lower silicon in a permanent mold. The percentage of combined carbon will always be high when a permanent mold is used. Once the proper mixture has been determined, that mixture is used irrespective of the thickness of walls or caliber of shell.

All the foundries of France engaged in this work, have been mobilized on a common basis and are using precisely the same methods of selection, analysis and general foundry procedure. This has not been done without enormous losses and vexatious delays, there have been many cases where the loss of the total heat has been reported and a loss of 40 per cent was not uncommon in the first stages. Team work, scientific methods and keeping everlastingly at it, have brought results. Today the output has reached staggering proportions—over 1,000,000 rounds per day are being made.

Starting from the pig, the manufacture of a steel forging involves many operations and a huge outlay for equipment. The steel is made, poured into ingots, rolled into rounds, cut into blanks, heated to the forging temperature, pressed into the rough shape, pierced and run through a draw bench before the forging is ready for machining. A shell cast in a permanent mold and starting from the pig has but two operations—melting and molding. The heat treatment of the steel shell before machining is completed is balanced by the heat treatment of the cast-iron shell before machining.

A steel forging for a 4.7-inch shell costs over $7.00 at the present writing.

(Concluded on page 455)

THE FOUNDRY DATA SHEET, OCTOBER, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

FORMULAS FOR THE FOUNDRYMAN

A Flux for Soldering

When gated patterns become detached they may be replaced easily provided a good soldering fluid is employed. In making zinc chloride flux, the following precautions should be observed to obtain the best results:

Cleanliness is an important essential in making a good soldering fluid. The acid should be placed in a clean vessel, either glass or pottery. Metal containers should not be used as they are corroded by the acid, which contaminates the flux.

To make one gallon of soldering fluid use three quarts of commercial hydrochloric acid and place it in a suitable vessel; add zinc until the acid is *cut*. If the zinc is dirty it should be cleaned by dipping in acid and washing. Add the zinc to the solution, piece by piece, to prevent boiling over or the generation of sufficient heat to break the vessel if the latter is glass; stir the solution occasionally.

When the action between the zinc and acid has ceased, and no further bubbles appear when it is stirred, the solution should be filtered through several thicknesses of cloth tied over the mouth of a second jar to which the solution is transferred; this should have a capacity of at least one gallon. Add the following to the filtered solution:

(1)	Warm soft water	1 pint
	Sal-ammoniac	6 ounces

Add the sal-ammoniac to the water and stir until dissolved.

(2)	Warm soft water	1 pint
	Chloride of tin	4 ounces

Add the chloride of tin to the water and stir until dissolved, and mix the three solutions. The mixture will be slightly cloudy, and can be clarified by the addition of a small amount of hydrochloric acid, which should be added one drop at a time until the solution clears. This soldering flux will not spatter under the hot iron.

THE FOUNDRY, DATA SHEET NO. 243, OCTOBER, 1917.

FORMULAS FOR THE FOUNDRYMAN

Soldering Aluminum Bronze

One great drawback to the extended use of aluminum bronze is the difficulty experienced in soldering the metal. This also applies to the tinning of the surface, so that this alloy cannot be used for articles that require the protection of a tin coating.

Copper Sulphate Flux

One method of soldering aluminum bronze employs a strong solution of copper sulphate as a flux. The parts to be soldered are immersed in the solution and are touched with an iron rod which produces a deposit of copper on the bronze. The parts are rinsed clean, when the coppered surfaces can be tinned and soldered. Instead of being coppered the surfaces can be nickeled, in which case it will appear that the bronze is really soldered.

The following flux, however, is more convenient as it permits the bronze to be coppered and soldered at one operation. Make the following solutions:

(1)	Dissolve dry copper carbonate	2 ounces
	Water	4 ounces
(2)	Hydrochloric acid	6 ounces
	Thin sheet iron	½ ounce

Let the iron stand in the acid over night, then gradually add solution No. 2 to solution No. 1. Add the acid slowly until effervescence ceases, and then add the rest rapidly. A clear green solution will result, to which is added 4 ounces of zinc chloride solution made as outlined in Data Sheet No. 243. This flux will deposit copper under the heat of the soldering iron to which the solder will adhere. The following solder should be used in connection with the flux:

	Per cent.
Tin	75
Lead	25

Melt together and run into convenient sticks.

THE FOUNDRY, DATA SHEET NO. 244, OCTOBER, 1917.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

Calculating Tensile From Transverse Strength

By W. J. Keep

Question:—Can tensile strength be calculated from the record of transverse strength?

Answer:—Thomas Box, in his "Strength of Materials," page 271, gives a formula for such a calculation, but he assumes that the neutral axis always is at the center of the test bar, which is true only for hardened tool steel and white iron. His formula follows:

$$T = \frac{W \times L \times 4.5}{[d - \sqrt{W \times L \times 4.5} \div (C \times b)]^2 \times b}$$

T = Maximum tensile strain on the extreme edge of the section, per square inch.

C = Maximum crushing stress on the extreme edge of the section, per square inch.

d = Depth of a rectangular test bar.

b = Breadth of the same bar.

L = Length of the same bar.

W = The transverse breaking load at the center of the bar.

This formula does not take into account the influence of the chemical elements in cast iron. "Strength of Materials" was published in 1888, before this influence was generally understood. This formula applies to steel and has been found to give reliable results.

In a tensile test the pull is supposed to be the same on all parts of the cross-section. In cast iron the grain is more open at the center of the section and, therefore, the outer grains are smaller and take more of the strain than those at the center. This open, center grain is produced by the silicon increasing graphite and is greater in a large section because the cooling is slower, giving the silicon a longer time in which to act. In any case, with cast iron, the outer portion is stronger than the center. With an even pull the central portions will stretch more and will throw the most of the load to the outside of the section. When the outer fibres give way, the central portion offers but little resistance.

Testing a similar bar transversely, at the instant of breaking, the leverage acting consists of a long arm equal to half of the distance between the supports and the short arm equal to the distance of the outer fibres from the neutral axis. The axis moves just as the bar breaks from the center of the test bar to a point near the outer fibres which are in compression. All of these conditions must be considered in a formula of this kind.

I made a machine which measured the amount of extension and compression on the outer fibres and it also gave the position of the neutral axis in a transverse test bar, 1 x 1 x 12 inches, also one 24 inches long. I made tests of tool steel, mild steel bars and of white cast iron and gray cast iron, containing varying percentages of silicon. I then developed formulas for the calculation of tensile and crushing strength from the records of transverse test bars and I constructed the accompanying table which gives a near approximation without the use of a special apparatus.

Measure the shrinkage per foot and the transverse strength of a test bar. If the test bars are longer, calculate the strength of a standard test bar, 12 inches long.

Referring to the table, find the measure of shrinkage of the size of the test bar used, or the silicon, as shown by analysis. Divide the transverse strength by the divisor for that size of bar as found opposite the shrinkage or silicon, to obtain the strength of a standard test bar, 1 inch square and 12 inches long. In the same horizontal line will be found the approximate value of *ct* and *ec*. Then use the following formula for a test bar 1 inch square and 12 inches long:

$$T = \frac{4.5\ W}{et}$$

$$C = \frac{4.5\ W}{ec'}$$

$$W = \frac{T\ et}{4.5}$$

T = Tensile strength per square inch of a test bar cast and tested 1 inch square.

C = Crushing strength of the same bar.

W = Transverse strength of the same bar.

et = Distance of the neutral axis from the outer fibres in tension at fracture.

ec = Distance of the neutral axis from the outer fibres under compression at fracture.

Calculating Tensile From Transverse Strength

TABLE DEVELOPED BY MR. KEEP

	Silicon, per cent	Measured shrinkage per foot ½ inch square	1 inch square	2 x 1 inches	Divisor to reduce strength to 1 x 1 x 12 inches of ½ inch square to 1 inch square	2 x 1 inch to 1 inch square	Distance of neutral axis from outer fibre et	ec
White cast iron	0 to 0.75	0.248	0.247	0.221	......	.....	0.500	0.500
Mild steel......	....	.....	.....	.....	......	.....	0.518	0.481
Gray cast iron.	1.00	0.183	0.158	0.147	0.1473	1.857	0.550	0.450
Gray cast iron.	1.50	0.171	0.145	0.134	0.1567	1.819	0.580	0.420
Gray cast iron.	2.00	0.159	0.133	0.122	0.1648	1.787	0.610	0.390
Gray cast iron.	2.50	0.147	0.120	0.109	0.1713	1.757	0.640	0.360
Gray cast iron.	3.00	0.135	0.108	0.096	0.1772	1.717	0.670	0.330
Gray cast iron.	3.50	0.123	0.095	0.083	0.1839	1.704	0.700	0.300

Metallic barium was first obtained by electrolysis of the fused chloride, but later was made as follows: Sodium amalgam is added to a hot, saturated solution of barium chloride; the sodium displaces the barium which forms an alloy with the mercury, and the latter, which is barium amalgam, is kneaded with water to remove all the sodium. It then is heated in a stream of hydrogen to volatilize the mercury. Barium is a bright, yellow metal, with a specific gravity of 3.6. It fuses at a red heat, but does not vaporize.

Large Foundry to Produce Cast Steel Truck Wheels

A large foundry and machine shop to be devoted exclusively to the manufacture of cast steel truck wheels is being built by the Standard Steel Castings Co., Cleveland, which recently increased its capital stock from $125,000 to $1,000,000 to cover the cost of the extensive improvements and additions that are being made. The new plant will cost approximately $350,000 and the melting equipment of the foundry will include two 3-ton electric furnaces and three 2-ton side-blow converters. The output of the foundry will be 400 cast steel truck wheels per day or 1300 tons per month, making a combined tonnage of 2000 tons per month for the two plants operated by this company. The machine shop will have sufficient capacity to finish this large output.

The Standard Steel Castings Co. was incorporated in 1912. Its foundry is located on West Seventy-third street and the Big Four railroad and at present has an output of 350 tons of steel castings per month. This will be doubled before the end of the year. The product consists of automobile and miscellaneous castings weighing less than 200 pounds each. When the additions are completed the Standard company will have one of the largest foundries in the United States devoted to the manufacture of truck wheels. Officers of the company follow: Julius F. Janes, president; Edwin H. Janes, vice president and treasurer, and Wm. R. McDonough, secretary and general manager. In addition to the officers, the board of directors includes the following: E. W. Moore, P. J. Morgan, M. C. Rosenfeld, R. M. Calfee, J. C. Fogg and B. C. Tucker.

Tentative Specifications for Brass Castings

American Society for Testing Materials Proposes Specifications for Non-ferrous Alloys for Railroad Equipment—Will Be Given Trial for a Year

NONFERROUS metals and alloys are engaging the attention of testing engineers to such an extent that specifications are being drawn for use of producer and consumer, which undoubtedly will result in a great improvement in brass foundry practice. At the annual meeting of the American Society for Testing Materials, held at Atlantic City, June 26 to 29, proposed tentative specifications for nonferrous alloys for railway equipment in ingots, castings and finished car and tender bearings were presented for consideration. This proposed standard will be given a trial for a year before it is presented for adoption. In the meantime criticisms are invited and these should be directed to William Campbell, chairman of the committee on nonferrous metals and alloys, Columbia University, New York. The proposed tentative specifications follow:

Proposed Tentative Specifications

Alloy.	Copper, per cent.	Lead, per cent.	Tin, per cent.	Zinc, per cent.	Iron, max., per cent.	Antimony, per cent.	Phosphorus, max., per cent.	Aluminum, per cent.	Sulphur, max., per cent.	Total impurity, excluding Zinz, per cent.
Bearing Metal No. 1	remainder	9-11	9-11	1.5*	0.4	0.5*	....	none	....	1.0
Bearing Metal No. 2	remainder	7-9	14-16	1.5*	0.4	0.5*	....	none	....	1.0
Bearing Metal No. 3	remainder	7.9	14-16	3.0*	0.4	0.5*	....	none	....	1.0
Bearing Metal No. 4	remainder	4-6	15-20	5.0*	0.4	0.5*	....	none	....	1.0
Bell Metal	remainder	16-18	0.25*	0.25*	0.25	0.25*	0.02	none	0.05	0.5
Babbitt Metal	0.5*	9-11	rem'dr	0.10*	0.05	15-17	....	none	....	0.75
Lining Metal	0.5*	4-6	rem'dr	0.10*	0.05	9-11	....	none	....	0.75

*Maximum.

1. — (*a*) These specifications cover the various non-ferrous alloys for locomotive equipment in ingots, castings and finished car and tender bearings.

(*b*) These alloys and the purposes for which they are frequently used are as follows:

Bearing Metals No. 1 and 2, for connection rod bearings, bushings, eccentric straps, driving box bearings, trailer truck bearings, cross head gibs, hub liners and miscellaneous bushings;

Bearing Metals No. 3 and No. 4, for lead-lined bearings, for locomotive tenders, freight and passenger car equipment;

Bell Metal, for locomotive bells only;

Babbitt Metal, for babbitting driving boxes, rod brasses, cross heads and for hub liners.

Lining Metal, for lining truck brasses, tender brasses and car brasses.

CHEMICAL PROPERTIES AND TESTS

2.—(*a*) As shown in the accompanying table, the alloys shall conform to these requirements as to chemical composition, with the permissible variations specified.

(*b*) Where no figures are given for impurity maximum, these elements may be present up to any amount to come within the total impurity specified, providing the material otherwise meets the chemical and physical tests. Where maximum percentages are specified, the elements referred to are considered as impurities and shall not be intentionally added.

3.—An analysis will be made by the purchaser or his representative from one ingot, casting or journal bearing representing each lot. The chemical composition thus determined shall conform to the requirements specified in section 2 for the particular alloy.

4.—(*a*) *Ingots.*—Drillings shall be taken with a drill at least ½ inch in diameter at a point midway between the heaviest and smallest cross-section of the ingot. For ingots having two or more sections, drillings shall be taken from each section. In the case of babbitt metal and lining metal, drillings so taken shall be melted in a thoroughly cleaned ladle with a little rosin flux and poured into a piece of thin section. This piece shall be sawed into three parts and the sawings therefrom thoroughly mixed to constitute the sample for chemical analysis.

(*b*) *Locomotive Castings.*—Drillings shall be taken with a drill as large as possible at such points in the casting as shall be thoroughly representative. Drillings through the skin shall be rejected. Drlllings thoroughly mixed shall constitute the sample for chemical analysis.

(*c*) *Car and Tender Bearings.* — Drillings shall be taken with a drill at least ½ inch in diameter, at three points on the bearing selected for physical test as specified in Section 5 (*b*) as widely separated as possible. Drillings representing the skin of the casting shall be rejected. These drillings, thoroughly mixed, shall constitute the sample for chemical analysis.

Drillings shall be taken in a like manner from the lining, exercising care that the drill does not penetrate the soldered surface.

(*d*) All samples, whether taken with a drill or saw, shall be kept free of oil and shall be magnetized to remove iron introduced in taking the sample.

PHYSICAL INSPECTION AND TESTS

5.—(*a*) *Locomotive Castings.*—The castings shall be sound, free brom blowholes, flaws or shrinkage cracks, and shall show good foundry practice and workmanship.

One casting representing each lot of locomotive bearings will be broken by the purchaser or his representative for examination of fracture. The fracture shall disclose no shrink discoloration, segregation, dross or dirt spots within ⅝ inch of the bored journal engaging surface, and shall show no distinct signs of imperfect mixture.

(*b*) *Car and Tender Bearings.*—The bearings shall be sound, free from sand, blowholes, flaws or shrinkage cracks and shall show good foundry practice and workmanship.

One bearing representing each lot will be broken by the purchaser or his representative for examination of fracture. The fracture shall show no shrink discoloration, segregation, dross or dirt spots within ½ inch of the bored journal engaging surface. This test shall be made before linings are applied. A second test shall be made after applicaton of the lining as follows:

(1) The suspended brass when tapped with a hammer shall give a distinct ring.

(2) The lining when chipped with a cold chisel shall tear from the soldered surface as distinguished from clean shearing.

6. (*a*) *Ingots.*—Each 5000 pound or fraction thereof shall constitute a lot. The ingot from which the sample is taken shall be included in the shipment.

(*b*) *Locomotive Castings.*—Each 100 castings or fracton thereof unless otherwise specified shall constitute a lot.

The manufacturer shall furnish, free of cost, one casting representing each lot for purpose of tests as specified in Sections 4 (*b*) and 5 (*a*).

(*c*) *Car and Tender Bearings.*—Each 300 bearings or fraction thereof, unless otherwise specified from each pattern shall constitute a lot.

The manufacturer shall furnish, free of cost, one bearing representing each lot for purposes of tests as specified in Sections 4 (*c*) and 5 (*b*).

PERMISSIBLE VARIATIONS IN DIMENSIONS

(FOR CAR AND TENDER BEARINGS ONLY.)

7.—(*a*) The purchaser will furnish drawings showing the dimensions of the bearings ordered and permissible variations therefrom and the bearings shall conform to these drawings within such permissible variations.

(*b*) The thickness at the center of the brass and of the complete bearing shall not vary more than $\frac{1}{32}$ inch over or under the normal thickness shown on the drawing. The thickness of the lining shall not vary more than $\frac{1}{32}$ inch over or under the normal thickness shown on the drawing.

WORKMANSHIP

8.—(*a*) *Locomotive Castings.*—The castings shall conform to the dimensions specified and shall show good workmanship generally.

(*b*) *Car and Tender Bearings.*—The bearings shall show good workmanship generally, and shall be free from mechanical imperfections. They shall be bored to a true radius, and with the axis parallel to the plane of the top and perpendicular to the side lugs and bearing flange. The lettering shall be clear and distinct. No emery shall be used on journal engaging surfaces on either the brass or the lining.

MARKING

9. (*a*) *Ingot.*—The manufacturer's marking only shall be required, unless otherwise specified.

(*b*) *Locomotive Castings.*—The lot number and other marks as required by the drawings shall be legibly marked on each casting.

(*c*) *Car and Tender Bearings.*—The name or initials of the manufacturer, the initials of the purchaser, type number, journal size, and lot number shall be legibly cast with raised figures on a depressed surface of each bearing, as shown on drawings.

INSPECTION AND REJECTION

10.—(*a*) Inspection may be made at the manufacturer's works where the ingots, locomotive castings or car and tender bearings are made, or at the point at which they are received, at the option of the purchaser.

(*b*) If the purchaser elects to have inspection made at the manufacturer's works, the inspector representing the purchaser shall have free entry at all times while work on the contract is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

11.—Failure to meet the chemical or physical specifications, or non-conformity to any of the above requirements as to permissible variations, dimensions and markings, constitute sufficient cause for rejection of the lot represented by the sample chosen.

Experiments With Sulphur in Copper

To ascertain the effect of the addition of sulphur to copper, the following interesting experiment was made: A small heat of copper was melted and when ready to pour, was treated with 1 per cent of roll sulphur. The metal was poured into a sand mold in the form of an elongated bar, 1 inch square. After the mold was filled, the head of the sprue ejected copper in the form of a spray accompanied by a buzzing noise. The head did not rise, but sank in the center and its circumference adjacent to the sand was efflorescent.

The casting was dark-colored externally and contained dirt or slag on the cope side, together with very fine, shallow pin holes. The fracture of the bar showed fibers arranged axially from the center. When the bar was broken, the fibers tore and gave the fracture the appearance of a flower. The center of the fracture was solid and dull red in color. The fibers which radiated from the center were bright, and near their outer end were sprinkled with fine, bright specks which probably were minute holes.

In the second experiment, a heat of electrolytic copper was treated with 1 per cent sulphur and 1 per cent of copper oxide. The casting, when poured, sprayed vigorously. The pouring head swelled badly and it resembled a cauliflower. When setting, the copper emitted a crackling noise. The bar only weighed two pounds, while the weight of the sulphur treated bar made from the same pattern was 2¾ pounds.

Externally, the casting was black and dirty; internally, the fracture was comparatively sound around the edges in contact with the sides of the mold. The center of the bar was honeycombed, the interiors of the cavities being as brilliant as if burnished. Compared with the sulphur-treated bar, the fracture was a deep red, which probably was due to the presence of nonovide of sulphur. When cast both bars emitted fumes of sulphur dioxide, but in the oxygen-treated bar the fumes were much more pronounced.

These experiments are of considerable interest in view of the fact that sulphur has been proposed as a deoxidizing agent in the sand-casting of copper. Unfortunately, however, this element has too great a chemical affinity for copper to be of service in this connection.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

A Non-Shrinkable Pattern Alloy

We would like a formula for a non-shrinkable pattern metal that will be lighter than the usual lead base alloys used for this purpose.

A non-shrinkable pattern metal is unknown, since all metals and alloys diminish to some extent in volume when changing from the liquid to the solid state. However, some alloys shrink less than others and one that is noted for its low shrinkage and which is used largely for making white metal patterns, follows: Zinc, 50 per cent, and tin, 50 per cent.

Core Sand Mixture for Globe Valves

We would like to have a good core sand mixture for globe valves weighing from 50 to 200 pounds.

The following mixture will serve your purpose: Old molding sand, 33 parts; new molding sand, 33 parts, and sharp sand, 33 parts. For each 35 parts of sand add one part of any linseed core oil. Wet with water to the proper consistency.

Another mixture consists of one-third each of new molding sand, old floor sand and sharp sand. For 80 parts of sand, add one part of dextrine for small cores, but reduce the percentage of dextrine for large cores.

Avoiding the Cutting of Cores

In producing heavy brass castings we are experiencing difficulty with the cores, since the metal cuts into them to such an extent that it is almost impossible to extract them from the castings. We have tried different core sand mixtures and have changed from an open to a close grade sand, without obtaining satisfactory results. Also linseed oil has been used as a binder in place of some of the other binding materials with which we have experimented.

Bronze that is heavily phosphorized will penetrate any core if it is poured hot and if the core is not protected externally by some infusible coating. In this case, linseed oil should be satisfactory as a binder. The same method of making the core should be continued and a large amount of sharp sand should be used so that the cores will be free and open. Make a mixture of a good grade of plumbago and molasses water, using this for a blacking to coat the cores. Next, mix the plumbago with a small amount of weak molasses water, sufficient to make a paste and rub this onto the core with the fingers and polish it until it shines. Leave no part of the core uncovered and have it quite warm when it is set into the mold, pouring before the metal cools. If these suggestions are followed, we believe your difficulty will be overcome.

Cause of Flaking

We use steel tubing in the manufacture of a machine. Some of the tubes are drawn tapering while others are flattened. These operations heretofore have been carried out before the tubes were copper-plated, but to reduce the cost we desire to copper them previous to drawing or shaping. We have used a cyanide copper solution for first coating, followed by a one hour acid copper de-

posit. While apparently satisfactory on the pieces formed before plating, we find that the deposit cracks and peels off the pieces we have plated before forming, the treatment evidently being too severe. Do you think a suitable solution can be prepared for our purpose at a nominal cost, or is the treatment unreasonable for a heavy deposit?

The difficulty as described may be the result of two causes. If the deposit cracks and breaks off in flakes from the cyanide copper deposit, the trouble is undoubtedly caused by insufficient acid in the solution. In this case we would advise gradually adding more acid until the deposit is sufficiently tough when deposited with a current density of 15 or 20 amperes per square foot; then if the surface of the tubes is rough, add one ounce of black molasses to every 25 gallons of copper solution. A deposit from this solution should withstand even more severe treatment than you mention. If the entire copper deposit actually peels in ribbons from the tubes, the cause is an unclean steel surface or incorrect conditions when using the cyanide copper bath.

Rough and Dirty Yellow Brass Castings

We are sending you a brass casting which you will note is rough and dirty on the surface and we would like to have your opinion for overcoming this difficulty. This casting must buff to a perfect finish. We will appreciate any suggestions on gating and pouring or on any other subject that will enable us to get castings free from pits.

An examination of the casting indicates that the metal is yellow brass, and the cause of the difficulty is unskillful pouring. The castings also are gated improperly. The pits which mar the entire surface of the casting are caused by the entrance of zinc oxide into the mold. There are several ways of overcoming the difficulty that might be suggested, but judging from the manner in which this casting is gated and poured, we believe the most economical way would be to change the alloy to a red brass. The first cost might be higher, but the ultimate saving would outweigh this consideration. We suggest the following alloy: Copper, 86.50 per cent; zinc, 6.50 per cent; tin, 3.50 per cent, and lead, 3.50 per cent. The castings should be gated on the heavy section about ½-inch from the piece that projects at right angles to the main casting; or, if this is inconvenient, the gate may be placed directly on the end opposite the point where it was placed on the casting submitted.

Minute Cavities in Brass Castings

We are experiencing considerable difficulty in manufacturing small brass castings. When the surfaces of these castings are machined, it seems as if the metal is torn away from the minute cavities by the tools. The mixture consists of copper, 82 per cent; tin, 10 per cent; lead, 8 per cent, and 5½ pounds of 15 per cent phosphor copper.

Your trouble may be attributed to any one of a number of causes and, therefore, a process of elimination will be necessary in order to ascertain the remedy. This difficulty may be due to the overoxidation of the metal or burning during the melting process. The remedy for this would be to use a fusible flux which, with the charcoal, will form a thick, tenacious cover over the metal as it melts. A cover for this purpose is fusible glass.

Also, your trouble may be caused by the exudation, as the metal solidifies, of a rich alloy of phosphorus, copper and tin, minute globules of which are comparatively hard and brittle and are torn out by the tools in machining. The remedy would be to lower the phosphorus content. However, we doubt whether this is the cause and we are inclined to believe that it is due to overoxidation.

It is possible, also, that your trouble may be due to the reaction between the chemical constituents of the alloy; to the moisture and the silica content of the sand or to some facing which you are using to protect the mold. A mold coated with silica wash is excellent for casting steel, but when used with phosphor bronze would produce spongy castings. We suggest the use of a coating of the best graphite obtainable; also, if possible, to reduce the phosphor copper to 0.5 per cent; it would be advisable to do this even if a slight increase has to be made in the tin content to obtain the necessary hardness.

Cleaning Brass Castings With Acid

Kindly let us know how to clean brass castings by the acid process.

For removing the sand from brass castings the following dip is widely used: Muriatic acid, 6 gallons; nitric acid, 1 gallon, and water, 2 gallons. The castings can remain in this dip for about 30 minutes until the sand falls off, when they are removed and rinsed in running water after which they are re-dipped in the following solution: Nitric and sulphuric acids, 1 gallon each, and salt, 1 ounce. To mix the acids, place the nitric acid in a strong crock into which the sulphuric acid is gently poured and great care should be exercised not to spill either of the acids. This solution should be mixed the day before it is to be used to give it plenty of time to cool before the castings are dipped. The mixing should be done out of doors, or under a hood connected to a chimney with a good draft. After the castings are dipped, they should be rinsed in cold water, followed by rinsing in hot water, after which they are dried in sawdust. To a large extent, the sandblast has replaced the acid cleaning method.

Can Government Metal be Forged?

We would like to know whether government metal can be forged, and if so, will you kindly give us the process?

The metal made from the formula of copper, 88 per cent; tin, 10 per cent, and zinc, 2 per cent, is the one to which you refer and so far as we can ascertain, this alloy has never been forged, since it is so brittle that it would crumble at a red heat. For forging purposes, we suggest the use of manganese or aluminum bronze. If manganese bronze is selected, it is customary to omit the aluminum which always is added to make this metal run better in sand castings. If aluminum bronze is preferred, melt 90 pounds of copper and 10 pounds of aluminum, stir thoroughly to secure a uniform composition and pour it at a medium temperature.

Removing Aluminum From Brass

Can aluminum be removed from brass? Our scrap consists of yellow brass castings made for automobiles, which contain a high percentage of aluminum.

Aluminum may be removed from copper alloys by oxidation, but unfortunately this is not a satisfactory process for yellow brass as the zinc, in addition to the aluminum, is lost. This is due partly to the high temperature generated by the oxidation of the aluminum which volatilizes the zinc, and also to the fact that the two metals oxidize as an alloy of aluminum and zinc. Therefore, it usually is necessary to remove all of the zinc to set free the aluminum, leaving only the copper.

The automobile castings to which you refer are manganese bronze, but if the scrap is heavy and is carefully sorted most of the manganese bronze can be removed and can be used for other purposes for which it is best adapted. Also, it can be mixed with red or yellow brass in the proportion of 5 or 10 per cent, keeping the amount just below the percentage at which the aluminum would show in the castings. This can be determined by experience. The method outlined is the most practical method devised for using this material.

Producing Machinable Malleable Iron Castings

Hard Iron, Underannealed Iron and Burned Iron Cause Trouble in the Machine Shop—Difficulties Easily Avoided by Intelligent Investigation

By A T Jeffery

THE advent of the automobile with the subsequent use of large quantities of malleable castings in its construction opened up a new line of troubles for the malleable manufacturer, with all of the old troubles seriously magnified. High-speed machinery puts malleable iron to a very severe test and the very best quality is not any too good for this purpose. Any product containing iron-carbide will be found unsatisfactory under these conditions.

White iron with its large percentage of iron-carbide will destroy the most costly tools just as quickly as it will the cheaper grades. In many cases it causes a delay of several hours, holding up the production of an expensive machine. Similar results, although perhaps to a lesser degree, will result from machining any iron containing even a small percentage of combined carbon. Iron with pearlitic rim will spring machine tools causing them to give oversize dimensions, making necessary a second operation. Iron with a thick decarbonized rim will clog the teeth of milling cutters and push ahead of a lathe tool that is properly ground for machining ordinary malleable.

Five Varieties Cause Trouble

There are five distinct varieties of iron from which one or more of these complaints may arise. They include pure, hard white iron, under-annealed iron, iron cooled too quickly, burned iron and iron that is sometimes called hard but is really tough and stringy.

Pure, hard white iron cannot get into the machine shop except through carelessness. It is very easily recognized by an expert, although to the uninitiated and under ordinary conditions it may be confused with under-annealed iron. The only remedy for pure white iron in the machine shop is care that hard and soft iron shall not be allowed to come in contact with each other or cross each other's path in passing from one department to another.

Under-annealed iron may be in two states, first as shown in Fig. 1, not affected by the heat of the annealing furnace. In this condition it has practically the same qualities as pure white iron except that initial strains due to cooling from the molten state have been removed. The second state is shown by Fig. 2. This iron will give all kinds of trouble in the machine shop. It will wear machine tools very rapidly, cause them to heat and will also strain the jigs and chucks unless they are massive and designed with a large factor of safety. It will show a black fracture when broken and cannot be detected except by chemical or preferably by microscopic analysis. It has little ductility and only slight resistance to shock.

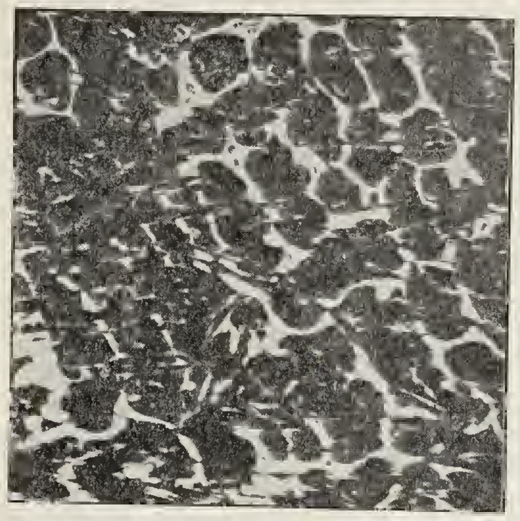
FIG. 1—MICROGRAPH OF WHITE IRON SHOWING FREE CEMENTITE IN WHITE AREA — DARK AREA IS PEARLITE

Either state of under-annealed iron is caused by lack of proper heat treatment. Annealing ovens with bad circulation, too large annealing pots or lack of proper knowledge or facilities for reading temperatures are the usual underlying causes. They are to be remedied by a scientific study of draft conditions, size and spacing of pots and the installation of adequate and reliable pyrometers. Large pots jammed tightly together forming nearly a solid mass of iron can heat only by the conduction of heat from the exposed tops, which must be at a considerably higher temperature than is necessary to anneal properly, in order to produce a flow of heat to the less exposed parts. There is thus a tendency toward false pyrometer readings of the actual temperature of the coldest part of the oven, the inside of the pot. There will be very little circulation of hot gases around the pots and they will go to the outlet that offers the least resistance and is the most direct. The outlets for gases should be so placed that the gases will be forced to come in contact with all parts of the oven and the intensity of the draft should be measured and gaged to insure a proper quantity of heat reaching every pot.

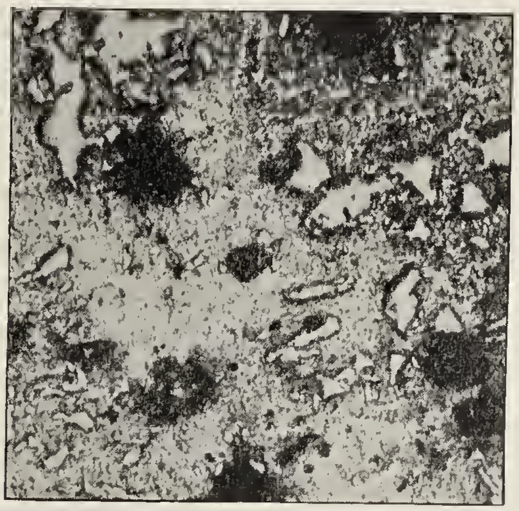
FIG. 2—UNDER-ANNEALED IRON SHOWING SOME FREE CEMENTITE

Test Lugs Are Useful

As a check on the efficiency of the heat treatment, test lugs should be placed on all castings. They should be broken by hammering and the quality of the iron determined. In the case of small castings at least one should be broken from the center of the bottom of each pot. There will be no trouble from under-annealed iron in the machine shop if these suggestions and precautions are carefully heeded.

One of the most aggravating troubles for the machinist is caused from iron with a pearlitic rim, as shown in Fig. 3. It will lead the machinist to register a vigorous kick and yet under ordinary tests the cause cannot be detected and the average observer will pronounce the iron good. The iron very likely will bend well when hammered and the fracture will be black except for the usual compression edge seen in all black heart malleable. Such iron, however, will wear and spring the machinist's tools and his verdict will be "hard iron." When subjected to the microscopic test, however, by a trained observer the trouble is easily determined; usually it is caused by too quick cooling. This has not caused it to be entirely returned to the white iron state and will not unless

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A paper read at the Boston meeting of the American Foundrymen's Association. The author, A. T. Jeffery, is assistant superintendent, Dayton Malleable Iron Co., Dayton, O.

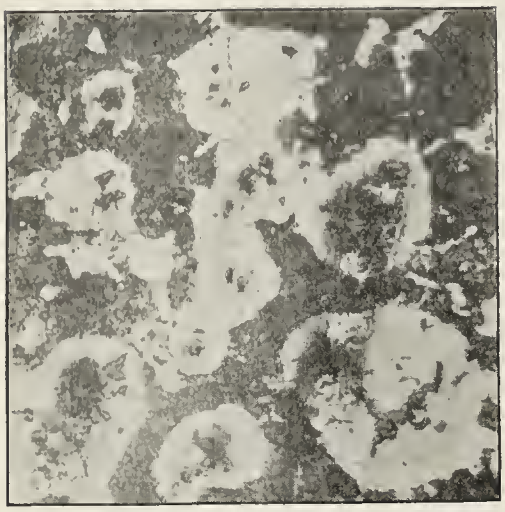


FIG. 3—IRON COOLED TOO QUICKLY, SHOWING PEARLITE IN DARK AREAS

the cooling is done at a very rapid rate.

Quick cooling is nearly always the result of carelessness or lack of knowledge of the consequences. Iron cooled faster than 20 degrees per hour will be in the danger zone. Bad dampers controlling the draft, fire and ash pit doors left open, cracked or leaky walls and removing the doors from the oven too soon will cause this trouble. A crack in the ash pit wall where the fire is above the floor line of the oven will furnish enough cold air to chill adjacent pots. The remedy is obvious. First, however, an educational program must be instituted, because workmen in charge of the annealing generally do not understand the detrimental features resulting from little acts of carelessness in looking after this part of their work. They are in the habit of judging from fracture and therefore do not detect anything serious when a piece of iron cooled too quickly is broken.

Burned iron affects the machinist in about the same manner as hard or annealed iron. It is perhaps a little more easily drilled and with very powerful tools may be machined. However, what has been said about hard iron will fit here also. Fortunately for the malleable manufacturer, burned iron is rare except as it creeps in at the tail end of a cast unobserved to be discovered later and laid at the door of the annealing oven when its identity is not fully ferreted out and properly accounted for. I am considering here as burned, that iron in which certain elements have been too far removed to allow the breaking up of the iron carbide in the annealing furnaces. Except in very rare cases it is not seriously damaged as far as its properties are concerned, although in those rare cases it will take on a honeycombed appearance and become absolutely useless except for remelting.

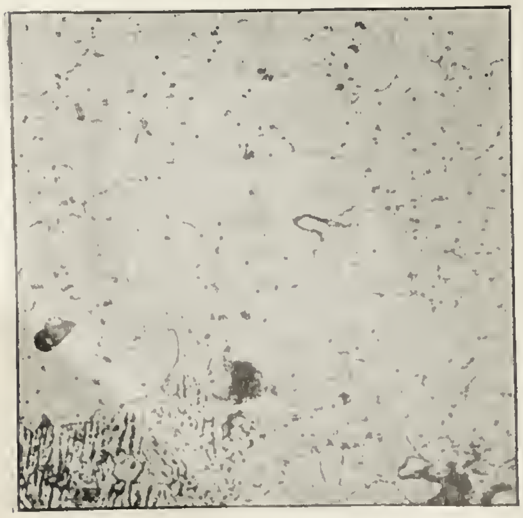


FIG. 4—DECARBONIZED RIM

If either the carbon or silicon is too much reduced in the melting furnace, iron will be produced that cannot be annealed, under ordinary conditions. Iron too low in silicon can be obtained by error in calculating the mixture, mistake in the chemical laboratory analyzing the pig iron or by excessive oxidation in the melting furnace. Manufacturers using a low-silicon, high-carbon mixture are most liable to encounter this condition. Error in the calculation of the mixture needs no comment; it is the result of carelessness or may be due to entrusting this work to an incompetent man.

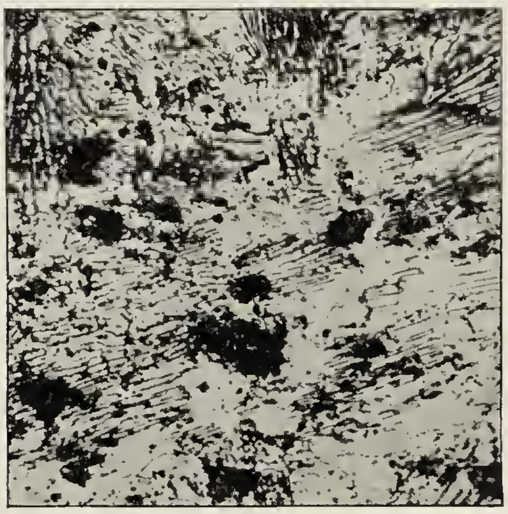


FIG. 5—FRAME OF PEARLITE

Bad chemical analyses may often be laid at the door of the blast furnace people, some of whom have had the honesty to admit that their analyses may be as much as 20 per cent off either way. The best way to eliminate this evil is to analyze each car of iron and use more than one car or kind of pig iron in the mixture, trusting in the law of averages to keep within proper limits. A furnace that is oxidizing rapidly will finish the job if the conditions mentioned are not watched; a sleepy fireman with holes in his fire or too much blast coupled with bad furnace practice will increase the danger. A well practiced eye aided with long experience in taking tests under standard conditions will help materially when low silicon is encountered because the eye will detect the trouble and our old friend ferrosilicon may be added to bring up the silicon content to the required amount.

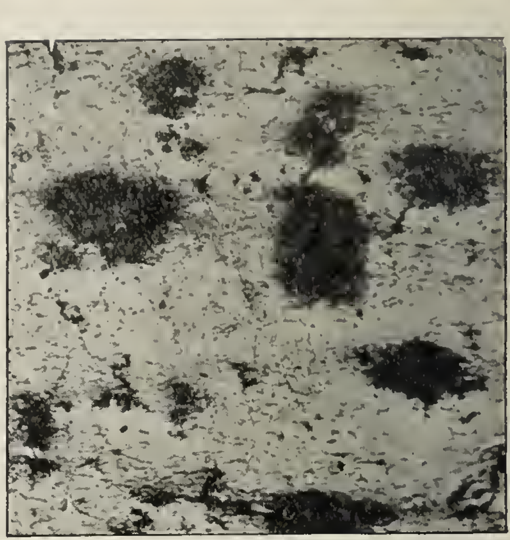


FIG. 6—CORE INSIDE OF FRAME

Carbon plays just as important a part as silicon and may or may not be low enough to give trouble when the silicon is low. When one considers that the best malleable is made with carbon hovering near 2.30 per cent and that 2.20 per cent is decidedly in the danger zone with ordinary malleable mixtures, also that pig iron may vary as much as 1 per cent in carbon, then one must prepare for trouble if he attempts to make low-carbon iron in large quantities with several furnaces running. Carbon is subject to about the same amount of oxidation as silicon under the same conditions, the only difference being that it cannot be replaced as readily. Therefore it behooves the most of us to play safe on carbon, at the same time protecting the machine shop from hard iron and also from semi-gray iron.

Last but not least of the sources of complaint from the machine shop is iron that bears the name of being hard but really is too soft and tough to machine readily. Most machine hands have had trouble at one time or another machining very good wrought iron. It pushes ahead of the tool and causes excessive chattering and wear, making necessary an extra cut, and in case the machine tool is weak it will jump out of the holding fixture and

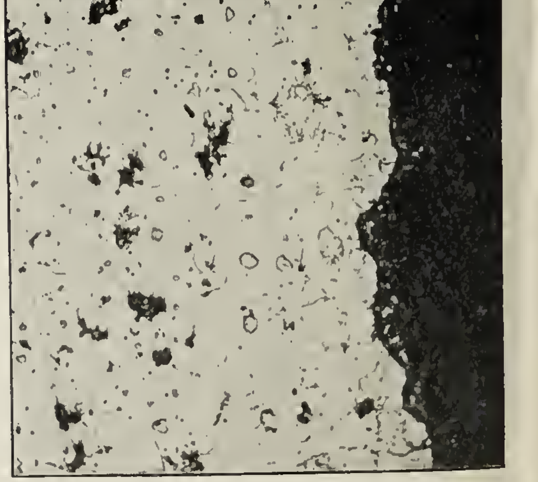


FIG. 7—DECARBONIZED RIM OF TOUGH MALLEABLE IRON

seriously strain the machine. The outside rim of extra-good malleable resembles the best wrought iron and closely rivals it all through the section. Its chemical make-up as far as iron is concerned is the same except that the particles of slag worked-in in wrought iron are replaced with particles of temper-carbon in malleable iron, as shown in Fig. 7.

Manufacturers of malleable iron should refuse to take this kind of iron back as foundry scrap. They should demand that the user provide sufficiently strong machine tools, run at such speeds as to readily care for this iron. The writer had occasion recently to inspect castings returned for being hard that had been drilled in several places and tapped in others without any apparent difficulty but upon boring a 12-inch dimension, the tool had evidently refused to cut. Microscopic analysis showed good, normal malleable, but upon investigation it was determined that the machining was done on an ordinary drill press using a boring bar in place of a drill running at high speed. The best of high-speed steel was used. On the other hand, a certain well-known manufacturer uses such sturdy machines that a chattering tool is rarely heard in the entire shop and when a casting is returned for being hard there is no doubt about the fact that it is hard. Of course, these are two extreme cases, but they serve to illustrate my point.

The malleable manufacturer can eliminate all trouble from this source by making relatively high-carbon iron, annealing it in nearly inert packing, producing iron that perhaps will pass as malleable. But at the same time he will be wandering away from the best practice and will not add to the reputation of the industry, which has suffered in the past from just such weak-hearted practice.

Summary

In summarizing, it may be said that the fundamental or underlying cause of trouble with malleable iron in the machine shop is generally due to a lack of scientific study of the material in question along practical lines and to the lack of active co-operation by the users of malleable iron. Designing engineers have neglected to familarize themselves with the properties and peculiarities of malleable iron due largely to the meager amount of authoritative information in print, and their unwillingness to accept the statements of men who are well informed but are perhaps unable to express themselves fluently and who are the operative heads of our best malleable foundries. In many instances bad designs are changed with reluctance, although the engineer is becoming more alive every day to the advantage and necessity of close co-operation with the practical man in the foundry. As in other spheres, therefore, *co-operation* should be our watchword and with intelligent effort and hearty co-operation between producer and user, most of our troubles will disappear.

Ladle Sleeves and Stoppers

Safety Standards Recommended at Boston Meeting of American Foundrymen's Association Adopted

ONE of the most interesting reports submitted at the Boston meeting of the American Foundrymen's association was that of the committee on steel foundry standards. This report, which recommends new standards for ladle sleeves and stoppers was unanimously adopted. The report in full is as follows:

"During the past year, the committee on steel foundry standards selected as its problem for investigation the standardization of standard sleeves, special sleeves and graphite ladle stopper heads, all of which is a sequel to the report on the standardization of ladle nozzles submitted at the Chicago convention in 1914.

"The standardization of ladle nozzles has been of inestimable value to both users and manufacturers. In these stirring times of top-notch production, the assurance of being able to obtain a standard product, rather than to have to wait for the manufacture of special designs has been a source of incalculable value and satisfaction.

"The committee, this year, proceeded much along the same lines as the original committee, obtaining an expression from 30 or 40 steel foundries indicating their practices. We found widely diversified opinions as to what constitutes good practice in stopper-rod equipment design. We also found that in some instances this all-important function of ladle equipment has received little or no consideration.

"We found, in general, that the thickness of the walls at the base of the special sleeves is insufficient. With the varying degrees of burning on the part of the sleeve manufacturers, this thin wall is often underburned and very fragile, causing disintegration at the temperature of molten steel. This permits the steel to find its way to the stopper-rod pin, often resulting in the loss of a stopper head. We also found that many foundries use a stopper head with only a short wall offset of ⅜-inch. We believe this dimension should be increased to 1⅝ inches to secure a better fit between stopper head and sleeve and a better alignment of the stopper head with the rod.

"We also found that the dimension for the insert of the stopper head and the recess of the special sleeve was the same. To safeguard against variations in depth and unevenness in the bearing faces of the recess of the special sleeve, we have recommended that the depth of the recess be made ⅛-inch greater than the height of the stopper head insert. To make it certain that the total stress and shock will not be carried by the shoulder of the stopper head, we would

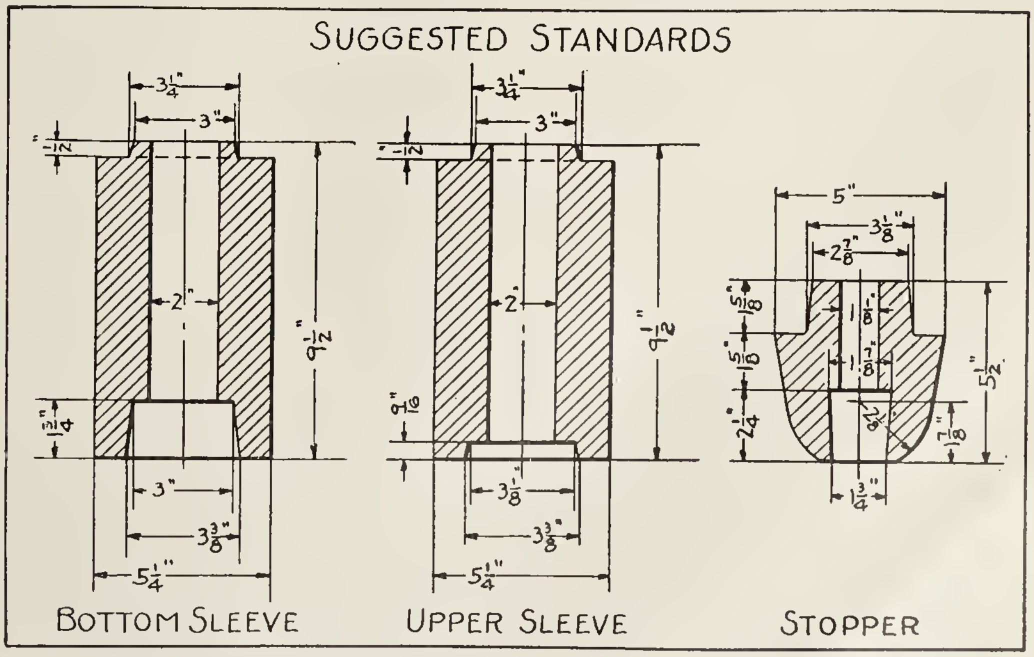
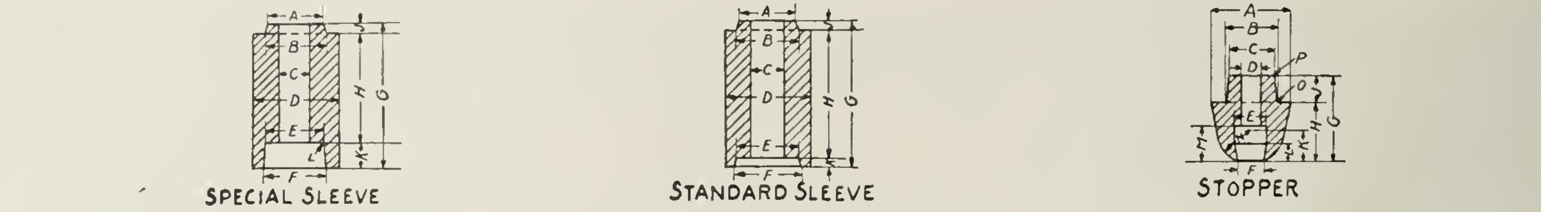


FIG. 1— SUGGESTED STANDARDS FOR SLEEVES AND STOPPERS



NAME OF FOUNDRY	SPECIAL SLEEVE										
	A	B	C	D	E	F	G	H	J	K	L
AMERICAN STEEL	3	3¼	2	5⅜	2⅛	3⅝	9⅜	7	⅜	2	SQ
BETTENDORF CO.	3¼	3⅜	2 3/32	5⅝	3½	3⅝	9½	7½	½	1½	⅛
BIRDSBORO STEEL CO.			TAPER - SEE SKETCH								
BUCKEYE STEEL CO.	3¼	3⅜	2 3/32	5	3½	3½	9⅞	7⅞	½	1½	
BUCYRUS CO	2 3/16	2¼	1⅞	4	2⅜	2 9/16	8⅛	7⅜	⅜	⅜	
CLEVELAND STEEL CO.	2 9/16	3⅝	2 1/16	5	2¼	3¼	9	6½	½	2	⅛
COMMONWEALTH STEEL CO.			TAPER- SEE SKETCH								
DETROIT STEEL CO.	3	3⅜	2⅜	5⅝	2 7/16	3¼	9 11/16	7½	7/16	2	
DUQUESNE STEEL CO.	2⅛	3	2	4½	2⅝	3	8⅜	7	⅜	1	SQ
FALK CO.				NOT USED							
GOULD COUPLER CO.	3⅛	3¼	2⅛	5	2 13/16	3 5/16	9½	7¼	½	1¾	
JONES & LAUGHLIN				NOT USED							
McCONWAY & TORLEY CO.	2⅝	2⅞	2	4	2¾	3	8 5/16	7½	5/16	½	
MESTA MACHINE CO.			TAPER- SEE SKETCH								
OHIO STEEL CO.				"			"		"		
OTIS STEEL CO.	2⅝	3¼	2	5	2¾	3¼	9½	8½	½	½	
PENN SEABOARD	3⅛	3¼	2	4½	3¼	3½	8 7/16	7 7/16	7/16	9/16	
SCULLIN STEEL CO.				SEE SKETCH							
STRONG STEEL CO.	3⅛	3 5/16	2⅛	5	2¾	3⅜	9¼	7 7/16	7/16	1¾	
UNION STEEL CO.			TAPER-SEE SKETCH								
WEST STEEL CO.				NOT USED							
								DIMENSION			

NAME OF FOUNDRY	STANDARD SLEEVE									
	A	B	C	D	E	F	G	H	J	K
AMERICAN STEEL	3	3¼	2	5⅜	3⅛	3½	9⅜	8½	⅜	½
BETTENDORF CO.	3⅛	3⅜	2⅛	5⅝	3¾	3½	9⅝	8 9/16	½	9/16
BIRDSBORO STEEL CO.	2⅝	3	2⅛	4	2¼	3¼	8⅞	7 7/16	7/16	½
BUCKEYE STEEL CO.	3¼	3⅜	2 3/32	5	3⅜	3½	9½	8½	½	½
BUCYRUS CO	2 3/16	2¼	1⅞	4	2⅛	2 15/16	8⅛	7⅛	⅜	⅜
CLEVELAND STEEL CO.	2¾	3 5/16	2 1/16	4¾	3	3½	9⅛	8⅛	½	½
COMMONWEALTH STEEL CO.	3¼	3¼	2⅛	6	3½	3½	8¾	7⅞	⅜	½
DETROIT STEEL CO.	3	3¼	1⅜	5	3 1/16	3 7/16	9⅜	8 9/16	⅜	7/16
DUQUESNE STEEL CO.	2¾	3	2	4½	2⅞	3 3/16	8⅜	7 9/16	⅜	7/16
FALK CO.	2½	3	2	4¼	2½	3	9½	8½	½	½
GOULD COUPLER CO.	3⅛	3¼	2⅛	5	3¼	3⅜	9½	8½	½	½
JONES & LAUGHLIN	3¼	3	2¼	4½	3⅛	3⅜	9	7⅞	½	⅝
McCONWAY & TORLEY CO.	2⅝	2⅞	2	4	2¾	3	8 7/16	7½	7/16	½
MESTA MACHINE CO.	2⅞	3¼	2⅛	4¾	3 1/16	3 7/16	9	8⅛	⅜	½
OHIO STEEL CO.	2 5/16	2 9/16	2⅛	5	2⅞	3⅛	9⅛	8⅝	7/16	⅜
OTIS STEEL CO.	2⅝	3⅛	2	4½	2¼	3¼	9½	8½	½	½
PENN SEABOARD	3⅛	3¼	2	5	3¼	3½	8 7/16	7 7/16	7/16	9/16
SCULLIN STEEL CO.	3⅛	3¼	2¼	6	3⅜	3½	9⅜	8½	⅜	½
STRONG STEEL CO.	3	3½	2⅛	4⅝	3	3½	9¾	8¾	½	½
UNION STEEL CO.			TAPER-SEE SKETCH							
WEST STEEL CO.	2⅜	2¼	1¾	4	2½	2⅞	8⅛	7⅛	⅜	⅜
	IN INCHES									

NAME OF FOUNDRY	STOPPER														
	A	B	C	D	E	F	G	H	J	K	L	M	N	O	P
AMERICAN STEEL	5 1/16	3	2⅝	1⅛	2¼	1¾	5 13/16	4 3/16	1⅝	2¼		2 1/16	2¼	SQ	SQ
BETTENDORF CO.	5	3 11/32	3 11/32	1⅛	1⅞	1⅝	5½	4	1½	1⅞	1⅛	2⅛	2⅛	⅛	⅛
BIRDSBORO STEEL CO.				SPECIAL - SEE SKETCH											
BUCKEYE STEEL CO.	5	3 13/32	3 11/32	1⅛	1⅞	1⅝	5½	4	1½	1 25/32	1⅛	2⅛	1⅞		
BUCYRUS CO	3⅞	2 9/16	2⅜	5/16	1⅜	1⅜	4 11/16	3½	1 3/16			1½	1 15/16		
CLEVELAND STEEL CO.	4 15/16	3¼	2 7/16	1 5/16	2¼	1 11/16	5½	3½	2		1½	1¾	1⅛	1/16	1/16
COMMONWEALTH STEEL CO.				SPECIAL - SEE SKETCH											
DETROIT STEEL CO.	4⅝	3⅛	2⅝	15/16	2	1 7/16	5⅜	3⅝	1¾	2⅛	1 1/16	2 3/16	1½	⅛	
DUQUESNE STEEL CO.	4	2⅝	2⅜	1	1⅞	1½	4 5/16	3¾	⅞	1½	1	1¾	1¾	SQ	SQ
FALK CO.	4 7/16	2⅞	2⅝	⅞	1 11/16	1 15/32	3 7/16	3½	7/16			1¾	1 7/32		
GOULD COUPLER CO.	5	3⅛	2⅝	1	1⅝	1½	5	3 5/16	1 11/16	3 5/16		1⅞	1½		
JONES & LAUGHLIN	4⅜			1⅛	2¼	1 11/16	4⅛					1⅞			
McCONWAY & TORLEY CO.	4 9/16	3⅜	2 9/16	15/16	1 5/16	1⅝	4⅝	4¼	⅜	1½		2 1/16	1½		
MESTA MACHINE CO.	4¾	3⅛	2¾	1¼	2	1¾	5⅜	4⅜	1	1⅝		1⅝	1⅝		
OHIO STEEL CO.	4⅞	2⅞	2½	1	1½	2½	6½	4½	2	2⅜		2⅜	1		
OTIS STEEL CO.	4⅝	3⅛	2⅝	⅞	1 5/16	1⅝	4⅝	4¼	⅜	1¼		2⅛	2		
PENN SEABOARD	5	3	3	1	1½	1⅞	3 15/16	3 9/16	⅜	2 5/16		1⅜	2½		
SCULLIN STEEL CO.	4½	3¼	2¾	1	2	1¾	4⅜	4	⅜			2⅛	2		
STRONG STEEL CO.	5¼	3¼	2¾	1	2⅛	1¾	5⅛	3½	1⅝	2⅛	1	2	2½		
UNION STEEL CO.	4⅝	3⅛	2 9/16		2⅜	1⅞	5 9/16	3 13/16	1¾		⅞	2	2 7/16	⅛	⅛
WEST STEEL CO.	4	2¾	2¼	⅞	1⅝	1½	4⅛	3¼	⅜	1	¾	1⅜	1¾		

FIG. 2—DIMENSIONS OF SLEEVES AND STOPPERS IN USE AMONG VARIOUS FOUNDRIES

suggest that a wadding or filler of clay be inserted between the top of the stopper head and the bearing face of the special sleeve.

"We realize full well that the recommended standards are quite a departure from the past practices of many foundries. We, however, urgently solicit the trial and co-operation of all foundries in their adoption and use. Your committee has made no recommendations or specifications covering the character of the clay composition or the degree of burning. The refractory manufacturers are more familiar with the nature of their raw material and the required burning than we are.

"A table covering a survey of the practice of various steel foundries and sketches showing the recommended standards is presented herewith."

Mixture for Stove Castings

By W. J. Keep

Question.—We would like to have an economical mixture for stove plate castings.

Answer.—The following analysis fairly represents American stove plate practice: Silicon, 2.77 per cent; sulphur, 0.076 per cent; phosphorus, 0.82 per cent, and manganese, 0.59 per cent. A range in the percentages of the elements is given in the following: Silicon, 2.25 to 2.75 per cent; sulphur, under 0.08 per cent; phosphorus, 0.60 to 0.90 per cent, and manganese, 0.60 to 0.80 per cent.

In my practice I never allow the silicon to go below 2.75 per cent and I prefer to have it as near 3 per cent as practical. The sulphur should be kept as low as possible, but under 0.08 per cent is as low as can be expected on account of the remelt which constitutes 40 per cent of the iron melted; 0.60 per cent is too low for phosphorus which should be nearer 1 per cent to make the iron fluid. Manganese, however should not exceed 0.50 per cent. High silicon irons generally contain more than 1 per cent of phosphorus. You can purchase other pig iron for your mixture containing manganese, 0.50 per cent. Considerable sulphur is absorbed from the coke and great care should be exercised to keep this element low.

Metallic titanium is inflammable only when in a finely-divided state; as solid metal it can be heated red hot and in this property it resembles iron.

Cerium melts at 635 degrees Cent.; its ultimate strength is 12,900 pounds per square inch. Its electrical conductivity is low and its thermal conductivity high.

The metal zirconium is obtained by mixing the oxide with finely-divided metallic calcium and heating the mixture in a vacuum. The product is treated with solvents to remove the gangue, leaving the zirconium in a finely-divided condition which is brought to the massive condition by melting in a Krptol electric furnace. Metallic zirconium is a grayish white metal of 6.44 specific gravity. Its melting point is 1530 degrees Cent.

Foundry to Make Automobile Castings

The Barnes Foundry & Mfg. Co., Detroit, recently organized with $2,000,000 capital, has acquired a site of 30 acres in Ecorse on which a large casting plant will be built for the manufacture of automobile cylinders, crank cases, pistons, etc. The property acquired is between the tracks of the Michigan Central and the Detroit, Toledo & Ironton railroads and is south of the property of the Great Lakes Engineering Works.

The officers of the company follow: Claire L. Barnes, president; George W. Smith, vice president, and Charles E. Pelton, secretary and treasurer. The directors include the foregoing officers with George A. Landon, vice president of the American Radiator Co.; Dwight B. Lee, general manager of the Motor Products Corp.; Edward A. Loveley, vice president of the Stormfeltz-Loveley Co.; Wm. E. Metzger and Frank G. Smith Jr.

Mr. Barnes, president of the company, formerly was vice president of the Detroit Steel Products Co., and for several years was connected with the Willys-Overland Co., Toledo. George W. Smith, vice president, is connected with the Case Threshing Machine Co., Racine, Wis., and Charles E. Pelton, secretary and treasurer, is connected with the Motor Products Corp., Detroit. C. E. McArthur, formerly affiliated with the Western Electric Co., and the International Harvester Co., will be superintendent of the plant.

Steel Castings for Ordnance Construction

Why Certain Specifications Are Unusually Severe—Classes of Gun Carriages and Physical Requirements for Castings Used in Ordnance Equipment

By Major C M Wesson

IN PRESENTING this paper on the subject of steel castings for ordnace construction, I sincerely hope I shall accomplish two purposes: First, to disabuse the minds of some of misunderstandings that I know exist; and second, to be of some assistance to others in the very important matter now with us of producing castings for war material. I purpose to deal principally with plain carbon steel castings, such as can be produced with any commercial installation, using the open-hearth, tropenas converter, bessemer converter or electric furnace, provided proper care is given to details, including finally, a simple heat treatment.

Special heat-treated and alloy-steel castings offer a wide field of endeavor, and our knowledge is rapidly increasing concerning them. The prediction is ventured that eventually they will displace the high-grade intricate forging, just as the plain casting, as we know it today, has in a large measure supplanted the plain forging. We have, however, not time to dwell on them here.

Development of Modern Field Artillery Began in 1900

A brief reference to the situation which resulted in the ordance department of the army undertaking the manufacturer of steel castings, instead of relying on the private manufacturer to produce them, may be of interest. The development of modern field artillery, which today has culminated in the glorious French Seventy-five, our own 3-inch field piece, and the French Schneider 11-inch howitzer, not to mention the engines of destruction used by our adversaries, began about 1900. This departure in type from the artillery carriage, familiar to all in the public squares of our towns and villages, necessitated, as will be explained later, steel castings of thin sections, of the best quality that could be produced. The inquiries proved that it was impossible to get such castings in this country, with the exception of one concern in New York state, which at that time was able to produce a small number of them. This situation resulted in great delays, and hampered our ordnance engineers in their development of the early experimental types of carriages. The large steel companies in Pennsylvania which were furnishing ordnance material, refused to undertake the manufacture of the thin-section castings, and even at a date very much later than this, took the stand that they were not able to make a steel casting of the distance ring for traversing rollers. This was at a time when, due to trouble with the forged steel rings, it was very desirable to procure cast steel ones. It is only fair to say in defense of the steel casting makers, that the inquiries for small steel castings were not for large lots; hence, the inducement to take up a new line of product was comparatively small. This condition aggravated the difficulties, and in the public files there is voluminous correspondence relating to the delays caused by inability to procure small castings. Quoting from a paper dated Feb. 19, 1899, the commanding officer of Watertown arsenal reported that "Shot trucks have been completed and issued. They were all completed except the steel trucks some months ago. Steel casting companies will not take small orders at this time." It was not long after this that a small converter plant was established at Watertown arsenal, due to this situation as regards the small thin casting, which plant has been in continuous operation since then. But why castings of this character? Why should the government ask for an article not demanded by the trade? I dare say the conclusion was reached in various quarters that the specifications were ill-advised, and were the offspring of ignorance and impracticability.

Let us consider for a moment, very briefly, the various classes of gun carriages in use, in the construction of which the large majority of castings under discussion are used.

Gun carriages may be divided into two distinct classes: (1) Carriages for mobile artillery and (2) carriages occupying a permanent or fixed position. It is evident that mobility of gun and mount will necessitate factors in design which are not necessarily considered in a carriage of the second class.

The question is often asked, "Why, for example, is the caliber of a certain gun set at 3 inches or 4.7 inches?" The answer to this is quite simple. The degree of mobility demanded of any piece will depend entirely on its character, being less for heavy siege guns where rapidity of movement is not so essential and greater for field guns which may by necessity have to be moved from place to place with great rapidity, as the progress of an engagement demands.

The power of any tractor or of draft horses must be taken for artillery purposes as less than that which would generally be taken in commercial work. This is due to the fact that on occasions considerable distances might have to be covered at high speeds; and secondly, the roads encountered generally will be inferior.

Problems of Design

Given, for example, the power of a tractive force (six-horse team), at 3900 pounds, the problem was to design a gun and carriage of the greatest possible power, with the requisite mobility to meet the tactical requirements of artillery operating in support of field armies. Considerations such as these led to the adoption, in our service, of the 3-inch field gun and, in the French service, of the 75-millimeter gun. Both of the types referred to are direct fire guns; that is, they are designed for firing at relatively small angles of elevation. If the evolution of the horse had resulted in an animal with the strength of an elephant and the speed of a deer, the modern light field gun, instead of being 3 inches in caliber, would probably be many inches greater, with a corresponding increase in power.

There is also provided in our service a howitzer of equal degree of mobiilty for each gun. The howitzer is a short gun, designed to fire at high angles of elevation, and is utilized for shelling protected positions or, in other words, employs curved fire to accomplish what direct fire would not do.

On the old type carriage, no provision was made for the recoil of the gun on the carriage. Upon firing such a gun, the carriage would jump to the rear

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A paper presented at the Boston meeting of the American Foundrymen's Association, Sept. 24-28. The author, Major C. M. Wesson, ordnance department, U. S. A., is officer in general charge of manufacture, Watertown arsenal, Watertown, Mass. Acknowledgment is made by the author to Dr. F. C. Langenburg, metallurgist; R. B. Farquhar, foundry superintendent, and J. M. Sampson, chief melter, for assistance rendered in the preparation of the paper.

many feet, and before the gun could be again fired, the carriage had to be laboriously returned to its original position, and the gun reaimed. Modern carriages permit of relative motion between the gun and carriage, and are fitted with a recoil system for absorbing the energy of the recoil. After the spade is once firmly embedded in the ground, no motion of the carriage to the rear will occur, and in this way the rapidity of fire is greatly increased.

Physical Requirements of Ordnance Materials

Table I

ORDNANCE STEEL SPECIFICATIONS

Metal	Elastic limit, lbs. per sq. in.	Tensile strength, lbs. per sq. in.	Elongation after rupture, per cent	Contraction of area, per cent
Cast steel, No. 1	25,000	60,000	16.0	24.0
Cast steel, No. 2	35,000	75,000	15.0	20.0
Cast steel, No. 3	45,000	85,000	12.0	18.0
Forged steel, No. 0*	......	......	....	....
Forged steel, No. 1	27,000	60,000	28.0	40.0
Forged steel, No. 2	35,000	75,000	20.0	30.0
Forged steel, No. 3	42,000	90,000	16.0	24.0
Forged steel, A	53,000	93,000	18.0	30.0
Forged steel, B†	65,000	95,000	18.0	30.0
Forged steel, C†	75,000	110,000	14.0	30.0
Forged steel, D†	100,000	120,000	14.0	30.0
Nickel steel, P1	63,000	100.000	18.0	....
Tool steel, A	75,000	125,000	16.0	35.0
Tool steel, B	95,000	140,000	12.0	20.0
Tire steel	50,000	100,000	17.0	30.0
Flange steel‡	40,000	64,000	20.0	45.0
Wrought iron	22,500	50,000	25.0	35.0
Cast iron, No. 1	......	22,000	....	....
Cast iron, No. 2§	......	28,000	....	....
Bronze, No. 1	......	28.000	....	....
Bronze, No. 2	......	35,000	....	....
Bronze, No. 3	......	45,000	....	....
Bronze, No. 4	......	60,000	20.0	....
Extruded bronze	......	50,000	12.0	....
Instrument bronze	......	38,000	....	....
Tobin bronze	......	52,000	30.0	....
Copper	......	32,000	22.0	....

*No physical test.

†Nickel alloy steels.

‡Physical requirements of commercial flange steel not indicated here.

§Cast iron, No. 2, must not show a tensile strength of more than 39,000 pounds per square inch.

The modern recoil system consists of a hydraulic recoil brake and counter recoil springs or compressed air, these latter being for the purpose of returning the gun to battery after recoil has occurred. The recoil brake consists of a cylinder filled with oil, in which moves a piston. An aperture having a constant or varying orifice is provided between cylinder and piston, one of which is attached to the gun, and the other to the carriage.

The relative motion of the cylinder and piston when the gun recoils, develops a pressure in the recoil cylinder due to the resistance offered by the liquid passing through the orifice between piston and cylinder. The braking action of such a system is very widely varied by the design, and is always adjusted so that the moment of this resistance with respect to the end of the trail is less than the moment of the weight of the gun and carriage with respect to the same point. This condition prevents the wheels from being lifted from the earth during recoil, and thereby disarranging the laying of the piece.

The recoil system outlined above is also applied to heavy seacoast guns and carriages, and it might be of interest to refer briefly to some of their main features. These mounts may be classified in general as either barbette or disappearing carriages. On the former the gun is always exposed above the parapet, while for the latter it is withdrawn behind the parapet by the force of the recoil after each round. As mobility, and in consequence lightness of construction is not a primary consideration in seacoast carriages, the designer has greater latitude in weights of materials employed, and such mounts can readily be constructed which will absorb the energy of recoil of guns of a much higher power than commonly used for mobile artillery. Guns mounted on barbette carriages are sometimes protected by turrets.

These machines form a group which throw projectiles from 12 pounds to two tons, to a distance of from 6000 to 21,000 yards. The tremendous energy of the recoil must be absorbed by the gun carriage which at the same time stores up a sufficient amount to return the gun to its original position on the carriage. This cycle must be accomplished without resultant disarrangement of the carriage; otherwise, the aim will have been disturbed, and rapid fire accurately placed cannot be delivered, and finally, no part of the carriage must be overstrained. The failure of a single part may, and probably will, put the piece out of the action. The painstaking care in the production of the 999 parts may be vitiated by the indifferent quality of the one part.

The force created by the explosion of the charge which sends a projectile on its way, the reaction from which has to be absorbed by the carriage, is sufficient, if uncontrolled, to demolish the gun, the carriage and the personnel which serve them. Further statement to prove that the ordnance engineer must demand material of good quality, appears unnecessary, except it may be added that considerations of mobility in the field pieces require the lest possible weight, which condition reduces the designer's factor of safety to limits far less than is ordinarily permitted in commercial construction.

Physical Requirements

Table I, taken from Form 434, "Instructions to Bidders and General Specifications, Etc.," gives the physical properties required of the various materials employed in carriage construction. Particular attention is invited to the three grades of cast steel Nos. 1, 2 and 3.

No. 1 castings are of very mild steel in which the presence of blowholes may be permitted when, in the inspector's judgment, they are not serious enough to affect the value of the casting for the purpose intended. Little trouble is encountered in manufacturing castings of this grade as the ductility requirements, 16 per cent elongation and 24 per cent contraction, are exceedingly reasonable. Cast steel No. 1 is used only on unimportant parts where the allowable section permits the use of a material having a low elastic limit.

Cast steel No. 2 with 35,000 pounds elastic limit, 75,000 pounds tensile strength, 15 per cent elongation and 20 per cent contraction is a better grade than No. 1, and must be free from blowholes. The American Society for Testing Materials on a grade of steel known as "Class B, hard," calls for 36,000 pounds elastic limit, 80,000 pounds tensile strength, 15 per cent elongation and 20 per cent contraction.

The society quoted above expects a higher elastic limit and tensile strength, as will be noted, for a given ductility than is demanded by the United States army. Attention is invited to this fact as there seems to be an opinion in some quarters that the ordnance specifications, U. S. A., are unreasonable.

Cast steel No. 3, 45,000 pounds elastic limit, 85,000 pounds tensile strength, 12 per cent elongation and 18 per cent contraction is a similar grade to No. 2, with the exception that the elastic limit and tensile strength have been increased and the ductility lowered. Both grades, Nos. 2 and 3, are used for important castings demanding good physical properties.

Proper design will limit the use of No. 3 to parts where the allowable section is limited and the stresses which must be endured demand the use of a material having a high elastic limit.

It is considered advisable to use No. 2 in preference to No. 3 for all members which can be made of such cross section that will allow of the use of a material having an elastic limit of 35,000 pounds.

Cast steel No. 3 is produced by a higher carbon content than is required for No. 2, and the heat treatment is in general different, as will be explained later.

As to composition, the only limitation imposed by the specifications, is that the phosphorus shall not exceed 0.05 per cent and the sulphur 0.07 per cent. Even under present conditions, there is no difficulty in complying with these requirements which are reasonable, less exacting than demanded by A. S. T. M., or the specifications for American railways, and are being met daily at your government arsenal at Watertown, Mass.

I desire to emphasize this point, as some casting makers recently have declined to produce castings for the government, on the grounds of the unreasonableness of the chemical specifications. *The Iron Trade Review* in an editorial on July 12 expressed its opinion on this question in connection with another subject. I may say here that I have been informed that issue has been taken with them on that editorial.

The endeavor thus far brings us to the conclusion of the first part of our topic, which is, to bring out that the specifications for government castings are reasonable, and not more difficult to meet than the requirements on which commercial engineering practice is based, and further that there are sufficient and proper reasons for exacting the reasonable qualities prescribed for them.

(*To be concluded*)

The Titanium Bronze Co., Inc., is the firm name of the corporation that has been organized to take over the bronze and brass casting department of the Titanium Alloy Mfg. Co., Niagara Falls, N. Y. The constantly increasing demand for the product of this department has compelled this move and the capacity of this foundry is being increased. The sales offices are located at 504 Marine Bank building, Buffalo; the general offices at 165 Broadway, New York, and district sales offices are maintained in the Peoples Gas building, Chicago, and the Oliver building, Pittsburgh.

Shells in Permanent Molds

(*Concluded from page 442*)

while a casting for the same shell can be made for a little over $2.00. Furthermore, a liberal saving in labor and machine-tool consumption can be effected. When larger projectiles are made, a larger proportionate saving will follow. When more than 1,000,000 rounds per day are made, and this is a low figure to expect, the difference in cost seems incredible. If $6,000,000 or $7,000,000 are spent each working day for shells alone, the incentive for saving a substantial portion of this tremendous outlay becomes a vital necessity especially when the cheaper shells will give as good if not better service than the more costly ones. There is no comparison between the shells when the question of output is considered. Taking dollar for dollar invested in equipment, the output of cast-iron shells is 10 times greater than the output of steel forgings.

The low cost, great output per day and the effectiveness of cast-iron shells have been so completely recognized that two of the warring nations are using them to an enormous extent. France is casting them in sand and Germany, from the best information available, is casting them in permanent molds.

Are Our Foundrymen Awake?

It is doubtful if there is a foundry in the United States that could qualify at once for this work without material changes in procedure. Primarily, it is not a commercial proposition and if this government decides to use cast-iron shells, the work must be undertaken with the foreknowledge that trouble is ahead. The necessity will be paramount of not only putting forth prodigious efforts but also of sinking individuality for the common good. A full and free interchange of ideas and data is indispensable. There is no doubt of the ultimate outcome, but if the experience of those who have been through the mill is utilized, a deal of time, trouble and treasure will be saved.

Personals

W. S. Spieth has been appointed manager of the Davis wheel department of the American Steel Foundries, Chicago, succeeding F. A. Lorenz Jr., resigned.

W. J. Kihn has resigned as foundry superintendent of the Gurney Electric Elevator Co., Honesdale, Pa., to accept a similar position with the Modern Foundry Co., Cincinnati.

Norman L. Warford, mechanical engineer in charge of construction for the Powdered Coal Engineering & Equipment Co., Chicago, sailed from New York recently to take up his new duties as engineer in charge of the coal pulverizing and copper smelting department of the Societe des Mines de Cuivre de Catemou at Catemou, Chile.

J. M. Barringer, formerly superintendent and sales manager of the American Malleables Co., Lancaster, N. Y., is now efficiency engineer for the Timken-Detroit Axle Co., Canton, O.

F. C. Fish has been appointed superintendent of the Marion Machine, Foundry & Supply Co., Marion, Ind. Mr. Fish was formerly superintendent of the foundry operated by the Advance-Rumley Co., La Porte, Ind.

Edgar Allen Custer, of Philadelphia, who has developed a permanent mold for producing castings without the use of sand, to a high state of perfection, has been assigned by the United States government to the munitions inspection department with the rank of major.

W. A. Janssen, who recently resigned as superintendent of the plant of the Bettendorf Co., Bettendorf, Iowa, has been appointed operating manager of the plants of the Canadian Steel Foundries, Ltd., Montreal, located at Longue Pointe and Pointe St. Charles, Quebec, and the steel foundry and rolling mill of this company at Welland, Ont.

J. M. Barringer, formerly superintendent and sales manager of the American Malleables Co., Lancaster, N. Y., now is connected with the Timken-Detroit Axle Co., Canton, O., in the capacity of efficiency engineer.

C. A. Crowe, formerly manager of the Grand Rapids office of the Asbestos Protected Metal Co., Pittsburgh, has been placed in charge of the Detroit office of this company and N. W. Taber, formerly manager of the Detroit office, has been appointed factory manager of the Asbestos Protected Metal Co.

The Detroit Foundrymen's Association held the first meeting of its 1917-18 season Sept. 13. A paper was read by C. D. Gilpin, Aluminum Castings Co., Detroit, on "Foundry Time Study Methods". The attendance was exceptionally large and the discussion of Mr. Gilpin's paper was spirited. The next meeting of the association will be held Oct. 11. L. G. Blunt will read a paper on "Gray Iron Foundry Practice".

Placet alloys essentially are mixtures of nickel and iron with chromium and manganese. The percentage of nickel is as high as possible in order to obtain wire with the minimum oxidizability. The product is used for electric resistance purposes.

Foundrymen Show Interest in Safety Problems

Report of Meeting of Foundry Section at National Safety Congress, New York, Sept. 13—Modern Treatment of Wounds Discussed

AMID the complex activities of the sixth annual Safety Congress, held in New York, Sept. 11-14, the foundry industry was prominently represented. As heretofore, a special session was devoted to the discussion of foundry safety problems. Approximately 250 representatives of American castings plants participated in this meeting which took place Thursday morning, Sept. 13. F. G. Bennett, safety director, Buckeye Steel Castings Co., Columbus, O., chairman of the foundry section, presided. He was assisted by F. W. Shepard, safety inspector, American Cast Iron Pipe Co., Birmingham, Ala., vice chairman, and S. W. Ashe, educational and welfare department, General Electric Co., Pittsfield, Mass., secretary.

Treatment of Burns

Following the formal reports of the officers of the section, W. E. Watters, National Malleable Castings Co., Melrose Park, Ill., presented a paper entitled, "Methods of Training and Obtaining the Co-operation of Foundry Foremen in Safety Work." Mr. Watters pointed out that it is necessary to assume a sympathetic attitude toward the men in the lower ranks in order to secure their co-operation. He recommended that the safety committees take part in the social activities of the men. Throughout his discourse, the necessity for approaching men on their social side was emphasized.

In the discussion of Mr. Watters' paper it was brought out that safety committees, in the activities of which the men take an active part, are more effective than any other device yet developed for securing co-operation in safety work. It also was suggested that trials of a more or less formal nature be held to ferret out the cause of every accident resulting in the loss of more than a day's time. The culpable persons, it was recommended, should be appropriately disciplined.

Unusual interest centered around a paper entitled, "Treatment of Foundry Burns by Paraffin Substances," by Dr. L. F. Mutschman, chief surgeon, American Steel Foundries, Alliance, O. Dr. Mutschman was unable to be present and the outlines of his paper were presented by S. W. Ashe, General Electric Co., Pittsfield, Mass. Mr. Ashe took up not only the use of paraffin substances for dressing burns but also the Carol-Dakin solution for preventing the infection of serious wounds, such as third degree burns. The methods of applying the Carol-Dakin solution and the paraffin dressing were described. It was stated these two remedies are probably the most important surgical discoveries resulting from the war.

In describing the Carol-Dakin solution, Mr. Ashe said it is 20 times as powerful as other antiseptics. Its success depends in a large measure on the skill with which it is applied.

The paraffin treatment of burns is not exactly new, but it has been recently developed to an effective stage as a result of war demands. The paraffin dressing cannot be used where the wound is infected or supperating. In such cases, the Carol-Dakin solution must be applied first, and the burn thoroughly sterilized. Generally speaking, the paraffin may be applied directly in the case of first and second degree burns.

New Officers
Metallurgical Section

Chairman
EARL B. MORGAN
Norton Co.,
Worcester, Mass.

Vice Chairman
F. H. ELAM
American Steel Foundries,
Chicago

Secretary
DUDLEY R. KENNEDY
Youngstown Sheet & Tube Co.,
Youngstown, O.

The details of the ambrine or paraffin treatment, as described by Mr. Ashe, are as follows:

"Formerly when a person was badly burned over a considerable surface, it was exceedingly difficult, even where skin grafting was resorted to, for the patient to recover. With the absorption of the body from the burns which occurred, kidney trouble resulted many times and the patient died. Also when the dressings were changed, the pain which the patient suffered was very intense, as the bandage coming off usually took with it some of the new skin which was forming. With the ambrine method, much of this trouble has been eliminated and the possibility of recovery has greatly increased.

"Ambrine itself is simply a very fine grade of paraffin containing antiseptic substances. Various substitutes have been developed in this country, due to the difficulty of obtaining an adequate supply of ambrine. Parresine, which is composed of a light grade of paraffin containing 2 per cent of eucalyptus is one of these substances. Whatever material is used is melted in a water jacketed atomizer and raised to the temperature of 150 degrees Fahr. It is then applied to the surface of the burn in the form of a fine spray.

"The wound is first thoroughly cleansed with a wash such as Carol-Dakin solution, then thoroughly dried before the paraffin mixture is applied. This is best accomplished by means of an electrical hair dryer. After the warm glaze coating has been applied to the burned surface, thin sheets of cotton gauze are placed over the surface of the burn and more ambrine or substitute is applied by means of a camel's hair brush. In this way the wound is completely sealed in a semi-adhesive shell. This process keeps out the air from the wound, and eliminates a very large part of the pain which is usually caused by such burns. Light bandages are placed over the ambrine for a period of several days. When the bandages are removed the shell easily peels off without bringing the new tissue with it. The results which have been obtained from this new method of treatment which is now being used by the United States Steel Corp. and the Schenectady and Pittsfield works of the General Electric Co., has resulted in decreasing notably the period of time necessary for complete recovery over the old method.

Introducing Treatment in America

"Dr. Wm. O'Neill Sherman, chief surgeon of the United States Steel Corp., was really the first to introduce the treatment in this country, and it is largely through his efforts that the new method has been taken up. One notable result in the treatment of third degree burns with the ambrine method is that no scars are left.

"The formula for No. 7 paraffin which may be used as a substitute for ambrine is presented in the ensuing table as follows:

	Per cent
Resorcin	1.00
Eucalyptus oil	2.00
Olive oil	5.00
Paraffin molle	25.00
Paraffin durum	67.00

"Melt the paraffin durum and add paraffin molle and olive oil. Dissolve the resorcin in absolute alcohol (soluble 2 in 1); add the alcohol resorcin and lastly add the eucalyptus oil when the wax has cooled to about 55 degrees Cent.

"A smaller amount of resorcin may be used. The whole of the resorcin does not remain in suspension, and we have used a paraffin containing 0.25 per cent resorcin with good results.

"Difficulty having been experienced in obtaining resorcin in large quantities, beta naphthol, which has the additional advantage of being a cheaper antiseptic, has been substituted for resorcin in more recent preparations. This formula is as follows:

	Per cent
Beta naphthol	0.25
Eucalyptus	2.00
Olive oil	5.00
Paraffin moll	25.00
Paraffin durum	67.75

"The mode of application of paraffin to the ulceration following frost bite is in every respect similar to the application of paraffin in the treatment of burns, and the results have been equally satisfactory."

Discussion of Paraffin Treatment

J. Stanford Brown, supervisor, department of labor safety and welfare, Carpenter Steel Co., Reading, Pa., said his company has been using the paraffin treatment for burns for three years with unusually satisfactory results.

W. L. Chandler, Dodge Mfg. Co., Mishawaka, Ind., asked whether the Carol-Dakin solution bites or stings and also how often ambrine applications are necessary in the case of burns.

His questions were answered by Dr. C. A. Lauffer, medical department, Westinghouse Electric & Mfg. Co., East Pittsburgh. Dr. Lauffer said the Carol-Dakin solution has considerable sting and that it is not comfortable. Also it burns the skin surrounding the wound if it comes in contact with it. Sometimes the skin is protected from this action by proper applications. In using the paraffin treatment of burns, Dr. Lauffer said it is necessary usually to dress the wounds daily. He also said that atomizers used to spray the paraffin or ambrine frequently clog and give trouble. He described a method of soaking gauze strips in melted paraffin or ambrine, laying them on the wound like shingles on a house, in order to avoid the employment of an atomizer. Preparatory treatment of the wound with the Dakin solution is always necessary in the case of third degree burns, he maintained.

F. W. Shepard, American Cast Iron Pipe Co., Birmingham, Ala., asked if it is good practice to allow first-aid men to apply the Carol-Dakin solution or paraffin substances.

Dr. Lauffer replied that first aid men should not be permitted to use these treatments under any circumstances. He explained that the technic is complicated and said success cannot be expected unless the treatments are in charge of skilled practitioners. This advice was approved by other physicians attending the meeting.

In response to a question by David S. Byer, Liberty Mutual Insurance Co., Boston, Dr. Lauffer said the paraffin treatment reduces the time required for a bad burn to heal fully 50 per cent. Also the wound heals practically without scar, the contractures being negligible.

An interesting paper on the relation between labor turnover and safety work was read by F. W. Shepard, safety inspector, American Cast Iron Pipe Co., Birmingham, Ala. Mr. Shepard pointed out that in the past three years the number of employes at the American company's plant has increased 30 per cent. During the same period the number of men employed one year or more increased 176 per cent; the number of men losing less than four day's time in a year increased 327 per cent; the number of men working every day in the year increased 455 per cent; the production increased 5 per cent; and the accidents decreased 47 per cent.

Mr. Shepard ascribes these remarkable results, particularly the reduction in the labor turnover to the welfare and accident prevention work of the company, which has made it an unusually desirable institution to be connected with. The results achieved are all the more remarkable when it is considered that a large proportion of the employes are colored. The American company promotes its own men, runs a medical and dental department, keeps up a workmen's benefit fund, operates a bank and supports a branch of the Y. M. C. A. Discipline is handled largely by a mutuality committee on which representatives of all the men have seats. The company recently has worked out a pension plan for its old employes.

A paper on "Practical Welfare Work in Foundries" was read by S. W. Ashe, General Electric Co., Pittsfield, Mass.

The foundry session concluded with a paper entitled "Mechanical Safeguarding of Electric Traveling Cranes", by J. Claude Smith, safety director, Inland Steel Co., Indiana Harbor, Ind. This paper covers safety devices for cranes in an exhaustive manner.

In reply to a question, Mr. Smith said he had not observed that cranemen's hours of labor have had any effect on crane accidents, although the 12-hour day is the rule. This was disputed by J. C. Feehan, factory inspector, state of Pennsylvania, Pittsburgh, who said there were four fatal crane accidents in the Pittsburgh district in 1916 which in his judgment could be ascribed to excessively long hours of labor. In one investigation, he said, the crane operators in the mill admitted they took naps while on duty.

In order to simplify the work of the Safety Council as a whole it was decided to consolidate the activities of the foundry and iron and steel sections. These sections in the future will be known as the metals and metallurgical division of the National Safety Council. The names of the officers of this division for the ensuing year accompany this report. It is probable that four sessions will be held by the metals and metallurgical division at the seventh annual Safety Congress next year. The place for the next meeting of the congress has not yet been selected. At the present time Cleveland is receiving the most serious consideration.

Influence of Impurities on Tensile Strength

By W. J. Keep

Question:—I have been seeking definite and reliable data on the effect of the ordinary impurities in cast iron on its tensile strength, but have been unable to locate such information.

Answer:—If you know the influence on the transverse strength of the ordinary impurities in cast iron, the same will apply to the tensile strength. If you will refer to the Transactions of the American Society of Mechanical Engineers, Vol. XXV, 1904, pages 884 to 919, you will find a series of tests which will give you all of the information that you desire.

The speed of cooling exerts more influence than slight changes in impurities and, therefore, a casting ½ inch square is much stronger per square inch than one of larger section.

A direct answer to your question is that iron with the closest grain and the least graphite is the strongest. Such iron, however, is liable to contain blowholes, shrinkage cracks and spots containing dirt. Slight additions of ferromanganese, ferrosilicon or aluminum will remove these without decreasing the strength of the solid parts. A further increase of silicon or aluminum will increase graphite and as soon as brittleness is overcome and the casting is as soft as needed for machining, any further increase will decrease strength by increasing graphite and causing the grains to become coarse and large. A further increase of manganese above 1 per cent hardens the casting, but increases the strength.

Working backwards, we will take a carwheel mixture as an example. An increase of sulphur will increase the chill and cause the grain to become closer, and if blowholes are not formed, the strength will be increased. When phosphorus is about 1 per cent or over, a peculiar grain is produced which will decrease the strength. For the strongest castings, all of these elements should be as low as possible. Phosphorus prolongs the period of fluidity and helps to fill the mold and to make a sharp casting. Silicon softens and acts like phosphorus as described, but increases graphite. Sulphur always is a disadvantage except in chilled castings. Manganese, however, is expected to eliminate to a large degree this annoying and unnecessary element.

Organizing for Welfare Work in Foundries

By S W Ashe

FOR some time many large foundries have carried on welfare work. Foundries that have undertaken such work are still continuing it, indicating that they feel it has been wise. However, it is difficult for the small plant with limited means at its disposal to know just what to do.

Statistics show that from 50 to 60 per cent of accidents are due either directly or indirectly to those employed less than six months. These accidents are due either to the carelessness or inexperience of the new man in either injuring himself or some one else. Thus if means can be developed for holding workers in employment for longer periods or decreasing labor turnover to reasonable proportions, accidents will automatically be reduced 50 per cent. In addition to heavy accident rates we find in plants with a high labor turnover, much restlessness, poor *esprit de corps,* little initiative and low efficiency.

EMPLOYES GARDEN AT PITTSFIELD WORKS OF GENERAL ELECTRIC CO. WITH EXPERT EXPLAINING POTATO DISEASES

There is no factor which means quite so much to an employe as the factor of stability. Where attempts are made to regulate production, so that employes are not periodically out of work, a better condition is created than in those places where a continual feeling of uncertainty exists. High labor turnover is the cause of more ills than it is ordinarily given credit for.

We can always trace some good in any form of welfare work, depending upon the angle we view it from, but the question naturally arises as to what counts the most. We should place ourselves in the position of the average employe and ask what really counts the most and what things in emergency we could dispense with. It is evident from this viewpoint, with the present high cost of living and with war conditions, that things which bear a direct relation to the employes' salary are the things which count the most. These are the things which necessarily exert the greatest holding influence. Company gardens, bonuses, selling articles, such as coal and insurance at cost, have the greatest weight these times. Where we get employes in the habit of saving their money and purchasing in bulk at the proper season we are not only establishing the fundamentals of thrift but at the same time we are solving many of the problems of labor turnover.

The average workingman has a large amount of free time at his disposal which should bring him in, if properly used, a fair revenue and when fall comes if this man has his cellar full of winter's coal, wood and vegetables and is in good physical condition as a result of his out-of-door activities, his whole viewpoint towards life and his company will change and he will stick to his job.

Establishing a company garden is equivalent to creating a medium whereby the employe can use his spare time to advantage and obtain a revenue which reduces considerably his living expenses. The employe benefits considerably by being in the open air, his spirits are better, his health is better and he is more cheerful and contented.

The accompanying illustration shows

(*Concluded on page* 467)

Presented at annual congress, National Safety council, New York, Sept. 11-14. The author, S. W. Ashe, is associated with the General Electric Co., Pittsfield, Mass.

Solving Electric Furnace Power Problems

Co-operation Between Central Station Men and Furnace Operators is Necessary to Secure Best Results—Future of Electric Furnace

By Edwin L Crosby

PROBABLY no instrument for the use of electrical energy for industrial purposes, other than the induction motor, has caused as much interest among both central-station operators and their patrons as the electric furnace, particularly in its application to the steel industry. Arriving as it did to that state of development which allowed its installation as an economically practical piece of apparatus simultaneously with an unprecedented demand for the very materials to the production of which it was most suitably adapted, the electric steel furnace has come in for very exhaustive consideration by the various individuals, manufacturing companies and societies interested in the production or sale of either steel castings, electric steel furnaces, or electrical energy.

Up to the present time approximately 200 steel furnaces of various types having an annual capacity of about 1,200,000 tons of steel have been installed or contracted for on this continent. This steel production involves the use of approximately 750,000,000 kilowatt-hours per year. Thus is the very healthy interest of the aggressive central station man in the problem justified.

Errors Have Been Made

Naturally in the attempt to secure all the new business possible by the use of electric furnaces, many concerns both in the steel castings trade and central station business have made serious errors. Many steelmakers and foundrymen have installed furnaces which for various reasons were utterly unsuitable for their use. Also many central stations have listened to the luring tales of various highly estimable furnace salesmen and permitted, even urged, the connection of furnaces to their lines, the operation of which was fatal to the happiness and peace of mind of the entire production department of the stations concerned. Beautiful visions of regulation equivalent to that of a lighting load, perfect phase balance, etc., have become nightmares of despair to not a few of the power companies of the country. Others have quoted rates for this class of service inconsistent with the characteristics of the load with rather disastrous results to their balance sheets.

To avoid unnecessary repetition of such occurrences it is essential that a closer study of the adaptability and operating characteristics of electric furnaces in general and the more common types of steel furnaces in particular be made by foundrymen contemplating the installation of such apparatus as well as by the central stations from which the foundrymen are likely to purchase power.

Has a Right to Advice

Any foundryman has a right to expect intelligent advice from his local central station on the electrical characteristics, their advantages or disadvantages, of any electrical equipment he may contemplate purchasing.

Central stations certainly stand ready to advise a storekeeper as to the best form of lighting equipment for him to use; they also are prepared to tell the power consumer which type of motor is best fitted for the particular purpose under consideration. An aggressive, wide-awake central station engineer is even able to advise intelligently upon problems involving various types of refrigeration equipment, valve gear, of air compressors, etc., giving due consideration to their effect on the customer's "demand", energy consumption, etc., and the consequent rate he would earn.

By the same token, the central station anticipating electric-furnace business should be prepared to discuss intelligently with the buyer of an electric furnace the electrical and metallurgical characteristics of the various types offered for sale. The power salesman must have a fairly good understanding of the metallurgical practice involved before he is able to give dependable data on the electrical performance of any furnace as these two matters are very closely related. For instance, an electric steel furnace connected to a large power system capable of handling large blocks of energy may be operated with less regard to fluctuating power input than if it were connected to a system of which the furnace constituted a large proportion of the total load.

Take a specific case—melting and refining cold scrap for small steel castings. The only limiting factor in the rate of current input during the melting period seems to be the effect upon the customer's demand. The scrap has an infinite capacity for absorbing heat, the refractories will not be injured, the radiation losses per heat are decreased and the electrical equipment, if properly designed, can stand considerable overload during this period, if it is really desirable to increase the rate of energy input. When refining, however, a much lower rate of heat, hence energy, input may be desired, perhaps only that rate necessary to maintain the temperature already acquired until sufficient time has elapsed for the desired chemical reactions to occur. It would seem, therefore, desirable to operate with a much higher arc voltage during the melting period, decreasing the potential when the bath becomes fluid and refining is begun. It is entirely possible that such a method may result in a lower cost of power per ton. Quite certainly it would result in a lower current consumption per ton, and if carefully controlled, an extra heat per day is easily obtained. Balanced against the increased demand charge per ton of metal are lower overhead charges, lower labor charges, lower radiation and electrical losses and general increased operating efficiency.

Co-operation is Needed

Here is where it is quite necessary for the central station man to assist the furnace user in determining the most economical point for operation. The method of determining demand and greater current fluctuations upon the distribution system are important factors in the determination of this point, and require a fair degree of familiarity with electric-furnace practice as well as with the central-station rate schedule.

In this connection, it is the writer's sincere belief that there is considerable opportunity for standardization of demands by the central stations of the country. It does not seem reasonable that local conditions are sufficiently diverse to account for the extremely variant methods now em-

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A paper presented at the annual meeting of the American Foundrymen's Association at Boston, Sept. 24-28. The author, Edwin L. Crosby, is affiliated with the Detroit Edison Co., Detroit.

ployed by companies selling service under relatively similar conditions.

While the cost of power per ton of steel produced is of course important, being one of the greatest tangible items in the cost sheet, the writer has visited several electric-furnace installations where power cost seemed to be the paramount issue, while in reality a lack of superintendence and generally loose organization ran up charges far in excess of any reasonable power cost. As a matter of fact, industry in general is rapidly awakening to the fact that with the present greatly increased cost of labor and material together with a very slight (if any) increased cost for electricity, the power cost of most any article manufactured is not as important as formerly was the case.

Heretofore, the greatest item for consideration among central stations desiring an electric furnace-load has been the power factor. There is no occasion for unrest upon this point at the present time, as very careful investigation of several furnaces of various types has shown that with the possible exception of one type of arc furnace, and the certain exception of the induction furnaces, all steel furnaces on the market today, if properly installed, will operate with a power factor of 0.80 to 0.85 during the early stage of the melting period, later rising to 0.85 to 0.90 and finally to a point as high as 0.95 or better during the refining period.

May Have a Leading Power Factor

Inasmuch as single-phase arc furnaces should never be connected to polyphase systems, except through phase converters, while induction furnaces operate more satisfactorily at frequencies below those in general use, thus requiring frequency changers, either of these types, thus equipped, may be connected to a polyphase system so as to impose unity or even a leading power factor.

Regulation, phase balance and wave distortion have not, on the other hand, received the attention they undoubtedly deserve. Present electrode regulation is at the best very unsatisfactory, it being impossible with any existing equipment to obtain sensitive regulation without considerable hunting of electrodes and disturbance of phase balance. If it is proposed to connect an electric furnace to a network properly designed to satisfactorily operate under existing conditions and with existing load, very careful consideration should be given to this point of regulation, and it may be advisable that carefully selected reactances be placed in the furnace circuit.

Recent oscillographic investigations have shown a very marked distortion of the current wave in all types of arc furnaces. This subject is a very important one as it may affect the accuracy of induction type watt-hour meters. Large wave distortion is also detrimental to the operation of other apparatus connected to the system, for instance, lowering the efficiency of rotary converters.

At first thought it may seem that such subjects are irrelevant before a foundrymen's meeting, but the writer wishes to call attention to the fact that it is necessary for a public utility serving any particular class of business to charge back to that class any expense contingent upon the service; so that if in order to superpose upon existing systems, satisfactorily operating any new form of load, it becomes necessary to increase the investment to an abnormal point, that investment must be reflected in the rate charged for the new class of business.

The writer does not wish to pose as an alarmist, nor does he believe that in the large majority of cases any such fears need be serious deterrents, but when a central station operating a transmission system of considerable length with somewhat limited capacity in generating and distributing equipment connected, attempts to take electric-furnace business, especially at rates based upon existing conditions, it is quite likely to get into serious difficulty which may later cause the station, as well as the furnace user, deep regret.

For the reasons mentioned it is obvious that the representative of a central station anticipating electric furnace business, should thoroughly familiarize himself not only with the operating characteristics of various types of electric furnaces, but also with his customers' requirements, and after careful consideration should offer an unprejudiced opinion upon the relative desirability of the various furnaces obtainable. It may be good judgment to advise against the electric furnace installation entirely. This was the writer's experience upon two occasions recently. Two customers having more or less scrap to sell and experiencing the universal difficulties in steel deliveries contemplated the installation of electric furnaces to supply their demands. After considering the investment, delivery on furnace and electrical equipment, the uncertainty of the market both during and after the war, the customer in each case was unhesitatingly advised not to make the installation. Incidentally, I believe any central station that urges the installation of electric furnaces for steel based upon the present market may later have cause for regret, unless he receives a rate commensurate with the risk.

The central station and the steel manufacturer have to consider from different standpoints the conditions peculiar to the present time, in deciding whether the investment in an electric furnace or the investment in the power plant and transmission necessary to supply that electric furnace should or should not be made. The steel manufacturer may be able to recover his entire investment by the sale of his output at high prices in a war time market which cannot get enough high-grade steel, whereas the central station is required by financial methods, and in some cases by law, to treat all of its investments as permanent, or if not permanent to be amortized over a long period of time, and is further required to have its rates for all classes of service consistent with one another. Therefore, the central station is compelled to consider the future of the steel market, the permanency of the service and the possibility of selling its capacity to some other industry in case the steel furnace should cease to be profitable to the manufacturer after the normal market conditions are restored.

Perhaps the demand for high-grade alloy steel for new uses after the war will keep all the electric furnaces busy. Perhaps the increased cost of labor and fuel will operate against the open-hearth or other less efficient processes sufficiently to allow the electric furnace to compete in ordinary tonnage production. The central station certainly hopes so. But meanwhile any installation should be carefully considered.

Such advice at this time is perhaps superfluous, as it is doubtful whether deliveries on electric furnace equipment are attractive enough to cause any great interest.

Should Compete Successfully

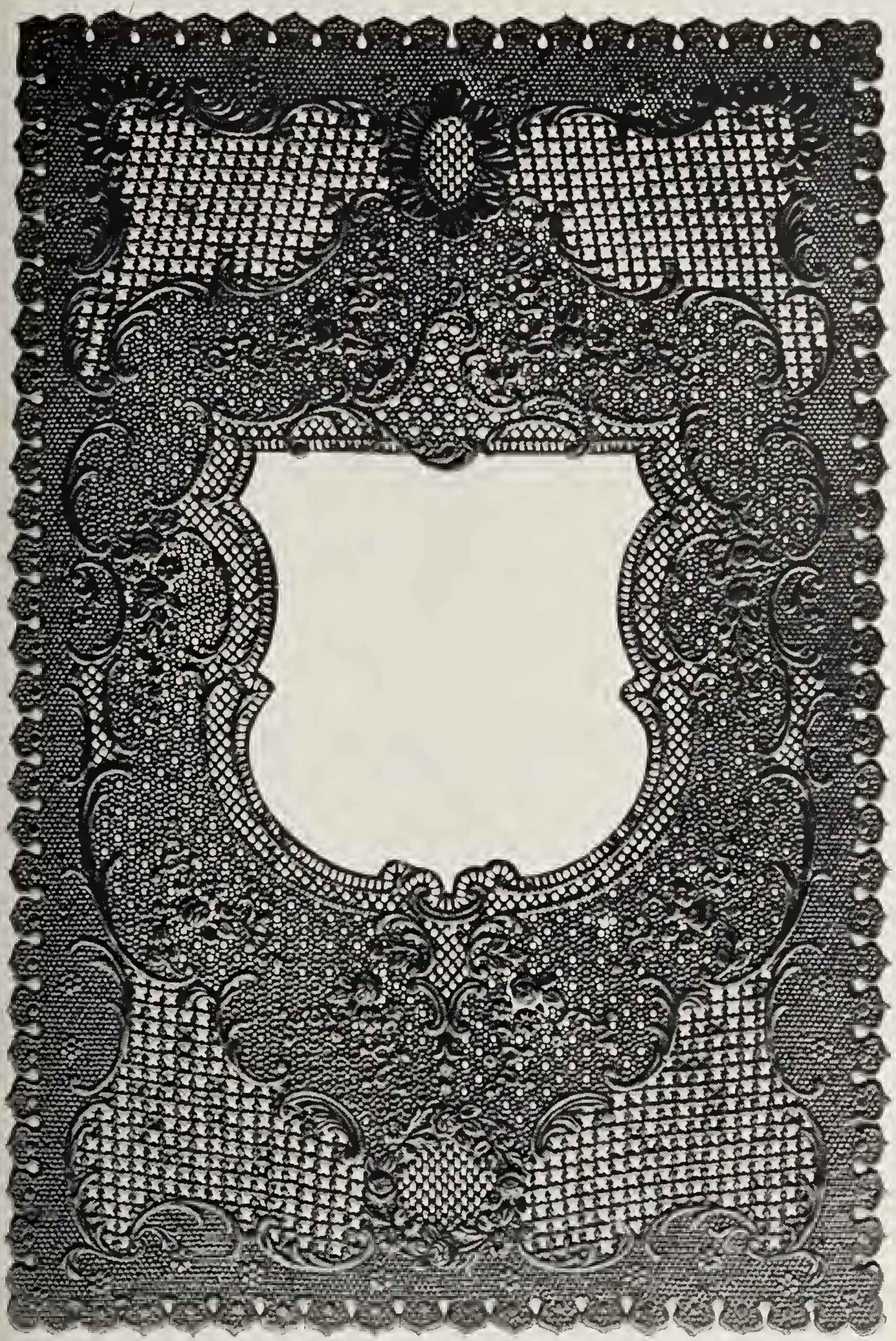
As stated in the report of the electric steel furnace committee to the National Electric Light association this year, that body believes that the electric furnace should supplant or successfully compete with the crucible or converter processes for any purpose. It should, given usual freight differentials, supply local markets with the equivalent of the higher grade open-hearth material, local scrap markets being favorable. However, under normal conditions the committee did not feel that the electric furnace was a competitor in tonnage steel.

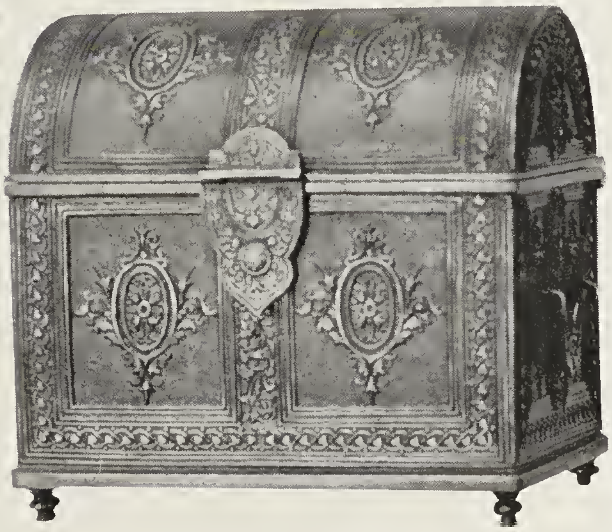
In the steel castings trade there appears to be no reason why the electric furnace, when thoroughly developed, should not supplant practically all other methods in foundry use. By

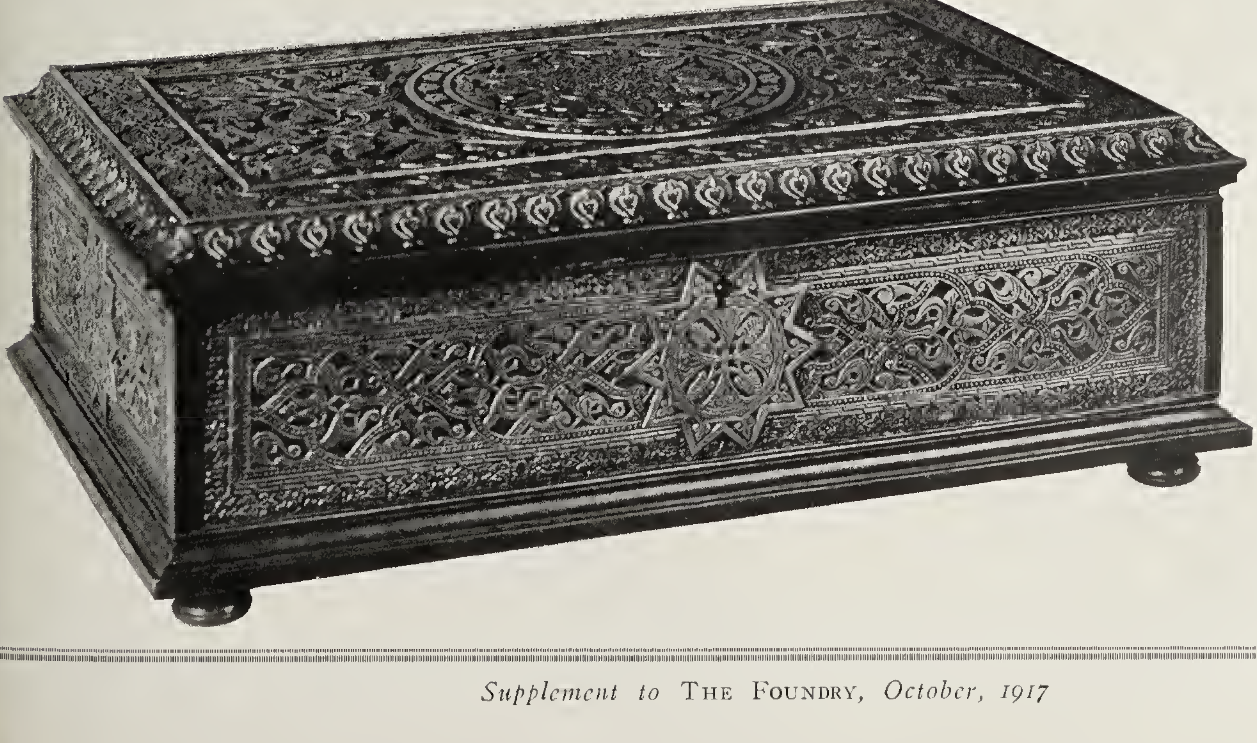
Craftwork in the Foundry

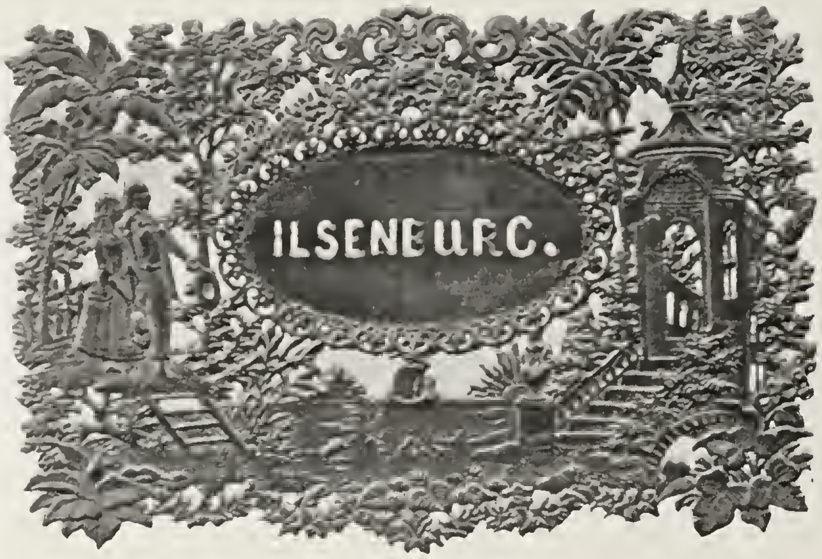
Remarkable Gray Iron Reproductions of Early Artisans' Masterpieces

THE period of the renaissance was marked by a revival of craftwork in metals throughout continental Europe and England. In France, Italy and Spain the tendency was toward the use of the rarer metals in filigrees and plaques of artistic and intricate design. The influence of the harsher climatic conditions of the northern countries is reflected in more substantial art pieces in iron and bronze. These consist largely of balustrades, cathedral doors and other productions for architectural purposes. Reproductions in gray iron of some of the fine art pieces in German museums are shown on this and the following page. With his wonderful ability to imitate, the German has reproduced in iron many of the artistic boxes and plaques wrought by the renaissance craftsman in gold and silver. The gray iron castings which are illustrated are a part of a collection owned by John A. Penton, of Cleveland. Additional views of the skillful work of German foundrymen will be published in the November issue of THE FOUNDRY.

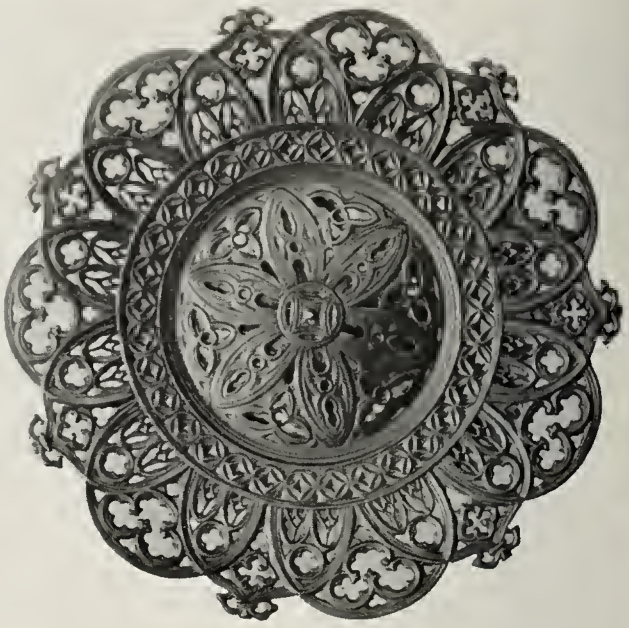

A remarkable example of skillful molding and pouring—This casting is so thin that it is as flexible as light cardboard—The uniformity of the border and interior designs show the foundryman's excellent technique


Many handsome gold and silver jewel boxes are exhibited in the German art museums —This is a copy of a plain handchased case

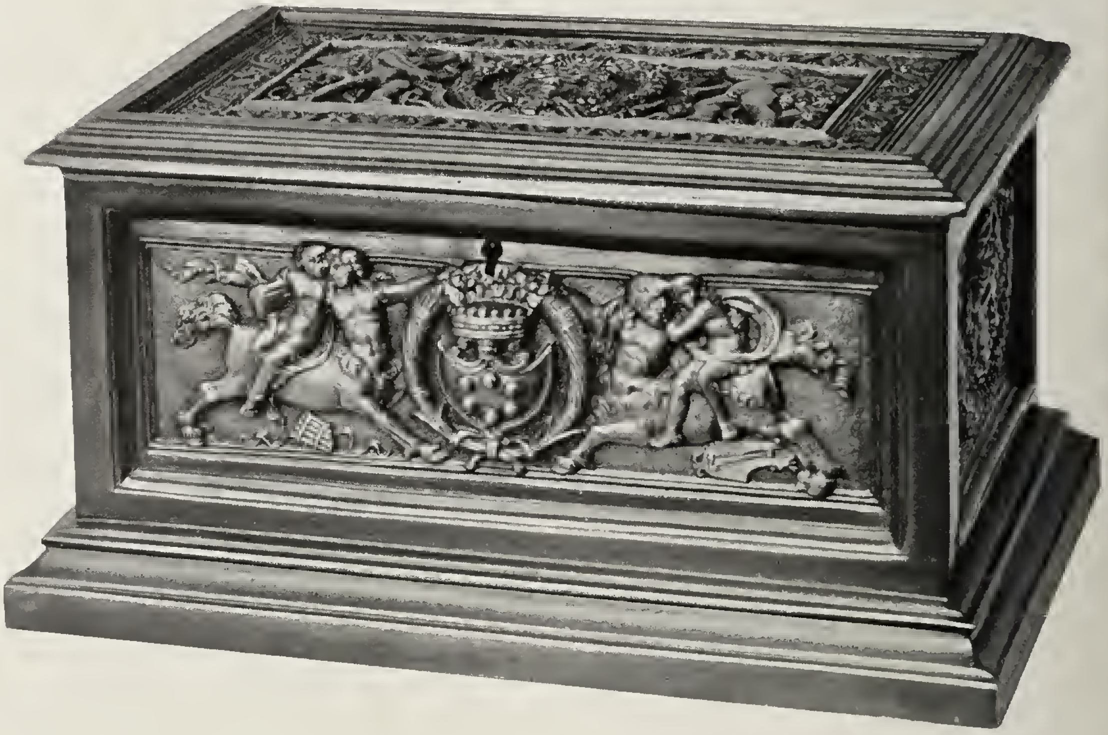

The original of the illustration at the left is about twelve inches long and eight inches wide—All the intricate details of the complex design have been ingeniously reproduced

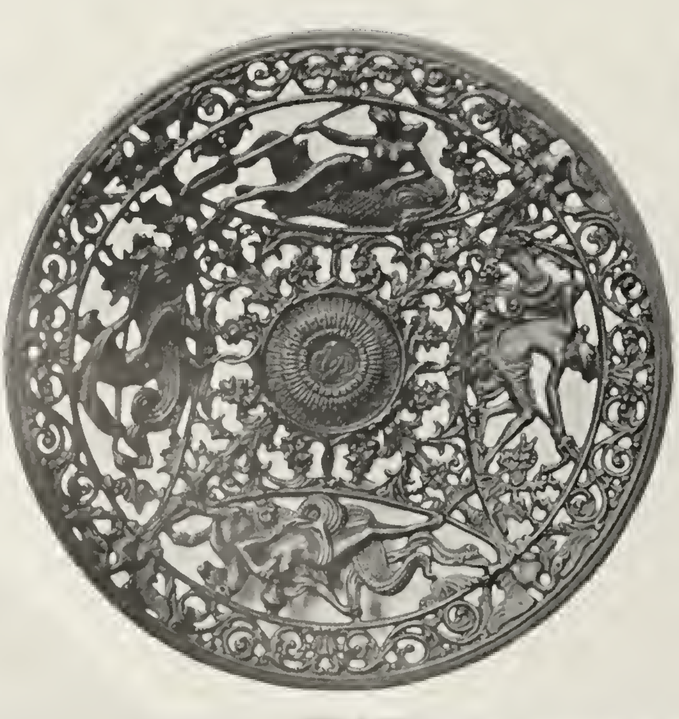


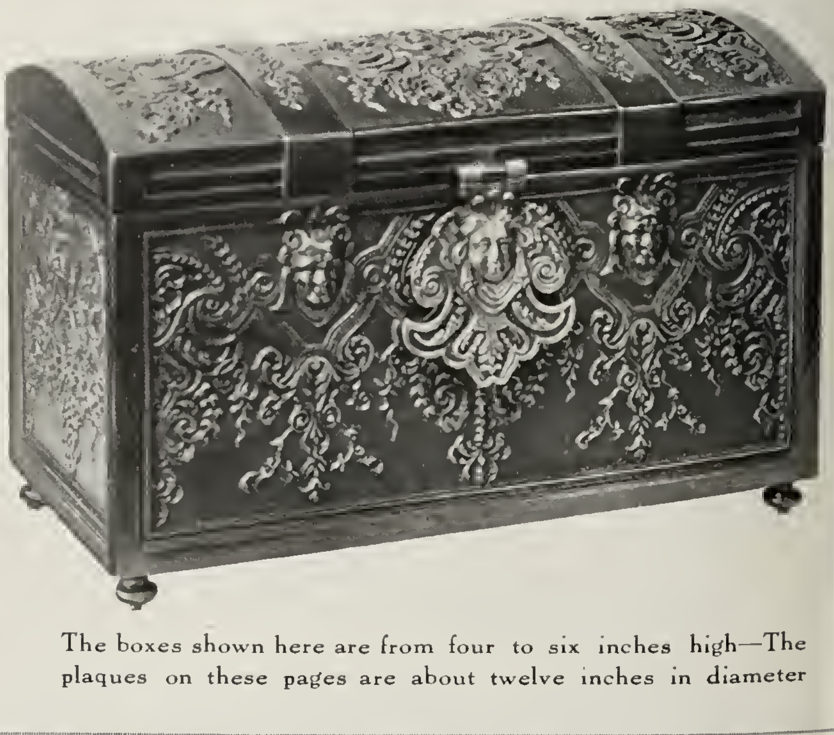
Cast iron calling card—More beautiful than useful



Finely polished surfaces reveal the high quality of the metal used for the production of these remarkable gray iron castings—The iron runs high in phosphorus and is unusually white in quality—This is shown by the various buffed surfaces of the plaques and boxes—A fine grade of green sand is used in making the molds—The thin cross-section of the two plaques makes them lace-like in appearance and weight







The boxes shown here are from four to six inches high—The plaques on these pages are about twelve inches in diameter close co-operation between foundrymen and the central station people that development can quickly be carried to completion. We may reasonably hope to realize that long anticipated ideal which I once heard stated at a meeting of this society by a representative of a competitor of the electric furnace, namely: "The electric furnace method is the *ideal* method for making *ideal* steel." The central station is willing to do its part.

A mixture of powdered aluminum, whiting, varnish and alum has been patented and is used for the purpose of filling joints or seams as a substitute for solder in the case of interlocking seams of metal cans.

Manganese Decreases Electrical Conductivity

Question:—We would like to know whether the addition of manganese to steel increases or decreases its electrical conductivity.

Answer:—Manganese steel is not magnetic. Electrical conductivity increases with the purity of the iron. Manganese is one of those elements which, according to the amount contained in the alloy greatly reduces electrical conductivity. Likewise nickel has an appreciable effect on this phenomenon and much in the same way.

Answering this inquiry direct, the degree of the electrical conductivity of steel is largely governed by the amount of manganese the alloy contains. The lower the manganese content the higher the conductivity, assuming that the percentage of other elements in the alloy are the same. However, one might obtain the same degree of conductivity with more nickel and less manganese, although it is unusual for steel containing a high percentage of manganese to contain also a high percentage of nickel.

As to the reason for the characteristics of certain elements and the affinities for others and combination of others, it is beyond the power of even a modern scientist to throw much light. We know that certain elements have certain characteristics and certain affinities for each other, but we know very little about why they act as they do.

Preventing Accidents in Industrial Yards

By F G Bennett

ATTENTION has been directed to this phase of accident prevention, no doubt by severity, rather than by frequency of accidents. There has been a general improvement in all plant yards in the iron and steel industry, where accident prevention work has been definitely established. This has been brought about by the recognized methods employed in accident prevention, engineering and organization. The engineering phase of this work will be slowly noticeable in established plants, but must be recognized in new construction. There are certain features along structural lines that, in our present plants, can be modified, but an extreme hardship will be placed upon certain companies where present construction is so established that changes are almost prohibitive.

Proper Clearance

In considering intrayard railroads, we must recognize a different condition than that of main line railroads where speed is a factor. This one aspect must have a bearing in formulating clearance rules, either from a statutory viewpoint or otherwise. The state commissions throughout this country, which have jurisdiction over railroads, have thoroughly covered the clearance problem, but this seems to be applicable to fast moving trains. In plant yards the movement of trains is practically limited to switching, placing of cars on loading tracks and other slow movements. In steel plants, there are movements that require speed, but this can be regulated and provisions made to insure safety. The subject of clearances would not be such a problem if new construction was to be considered, but in established plants where buildings have stood for a number of years, it is almost prohibitive to make modifications to which clearance rules can be applied.

At a recent public hearing before the committee which is endeavoring to formulate rules to govern intrayard railroads under the direction of the industrial commission of Ohio, the question was raised as to what a safe clearance should be in plant yards, and a majority favored 6 feet 6 inches from center to track. The state of Ohio public utilities commission has adopted a clearance of 7 feet from center of track.

In plant yards in connection with railroad tracks, there are always conditions where special safety measures such as warning signs and other mechanical devices that will warn employes of close clearances, must be employed. In plants where old installations prevent the application of defined clearance rules, such measures are necessary.

Overhead clearances in plant yards are most commonly applicable to entrances to buildings and this must be carefully studied and considered when formulating a clearance rule. The roller type door is of particular importance in the matter of overhead clearances. If too great a clearance is designated, there is danger of the door not being raised its entire height of travel, due to the fact that it requires more exertion to operate, and in some cases motive power would have to be used. This would be the case, no matter what clearance rule would be adopted, but the present requirement of Ohio in cases of this kind is a clearance of 21 feet. A clearance of less than 21 feet can be adopted and with the use of warning signs or other devices, should be ample in relation to safety. Other conditions in connection with the clearance problems such as double tracks, curves, switches, canopies, awnings, etc., can be satisfactorily handled after the lateral and overhead rules have been definitely arrived at. The speed of trains and locomotives in plant yards should receive attention and in most of our plants this is taken care of through discipline and rules.

Keep Your Yard Clean

A phase of this subject that cannot be lightly passed over is general cleanliness and tidiness throughout plant yards. This applies more directly to railroad tracks and an unceasing campaign to remedy this evil should be inaugurated. A clean-up gang in the larger plants, whose duties are limited exclusively to keeping the plant in a clean and orderly condition will find sufficient work to take up their allotted time. Barriers, constructed of timber of sufficient height to prevent material rolling down should be erected at the base of all piles which are located adjacent to tracks. These barriers, of course, should be placed in compliance with clearance rules.

In connection with railroad tracks there are, of course, quite a few accepted safety devices, such as enclosed frogs, switches, locking devices, derailers and signals that are helpful.

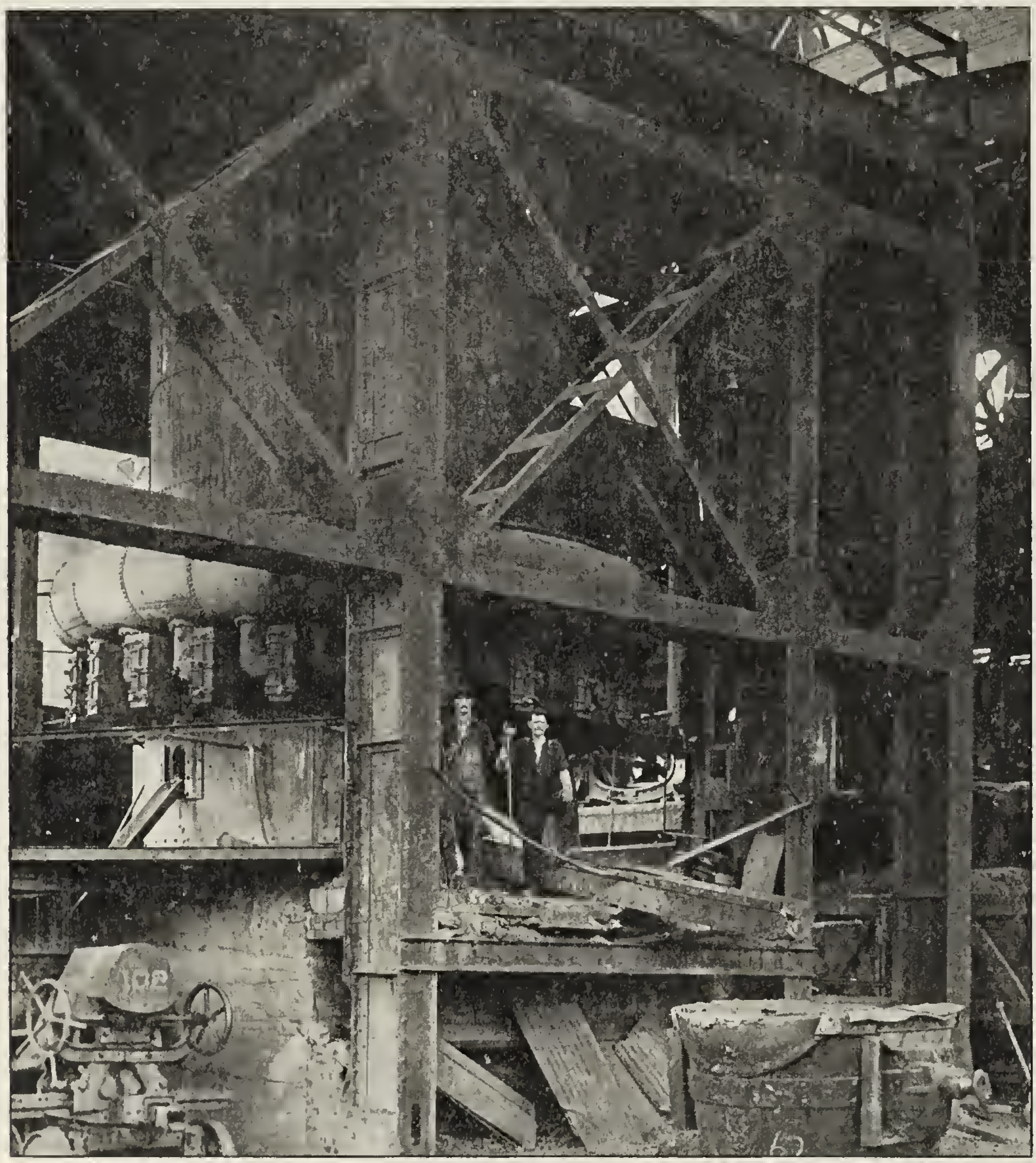
Presented at annual meeting of National Safety council, New York, Sept. 11-14. The author, F. G. Bennett, is director of safety, Buckeye Steel Castings Co., Columbus, O.

Pedestrians in and about plant yards require protection and there are many devices employed at the present time in this respect. Warning signs and baffles at grade crossings near corners of buildings and at doorways furnish protection that is acceptable to safety engineers today. Buildings which are located close to railroad tracks should have the windows on the ground floors closed by screen or strips to prevent employes using them as a means of exit. Designated foot walks about plant yards will help to prevent employes from using other avenues and short cuts. The use of railroad tracks as pedestrial avenues should be prohibited.

Vehicular traffic, both horse and motor, demands attention, as the latter is being more commonly used each day. The usual traffic rules should apply to motor trucks in plant yards as are in use on the public highway. It is possible to exercise more direct supervision over drivers who are in plant yards than those on the public thoroughfares and as there are not many of this class of employes, good results can be attained. It is exceedingly important that proper roadways and cross-overs be provided and maintained in good order.

A great many plants, engaged either directly or indirectly in the production of munitions and supplies for the war, have adopted extraordinary measures in the matter of protection from plotters and others intent upon interfering with this work. The lighting of plant yards by means of projected rays from searchlights has become popular, but all should give this matter close attention. The effects of the glare of these intense rays are well known and care should be exercised to see that railroaders and others are not subjected to the direct effect of these lights. This applies also to street cars and outside railroads that may run close to the boundaries of a plant. If possible, these lights should be placed at a considerable height and better results can be attained by flooding the area in this manner than by locating these lights on fences and other fixtures near the ground.

There is no doubt as to the importance of safety work in yard practices and defined and studied methods should be employed. All must remember that employes of shops and buildings are permitted the freedom of plant yards at times and they practically constitute a third party.



SCRAP MELTING CUPOLA 14 FEET IN DIAMETER IN OPERATION AT MINNEQUA WORKS OF COLORADO FUEL & IRON CO.

Large Scrap Melting Cupola

What is believed to be one of the largest cupolas in the United States is in operation at the Minnequa works of the Colorado Fuel & Iron Co., Pueblo, Colo. It is employed for remelting ladle skulls and other scrap. It is 14 feet in diameter inside of lining and about 28 feet in height above the hearth. It is of the bessemer type and is provided with a bustle-pipe and individual tuyeres instead of a wind-box. In this respect it is similar in construction to a blast furnace. In fact, it is equivalent in capacity to many of the small furnaces in operation 20 years ago.

The output is about 300 gross tons per day. The hot metal is transferred in ladle cars directly to the open-hearth furnaces, without being put through a mixer. The cupola, therefore, materially augments the output of the blast furnaces at the Minnequa works, and in times like the present, when tonnage is the chief consideration, it is of immense advantage.

The general arrangement of the charging platform, which is of steel plate construction, is shown clearly in the accompanying illustration. The cupola is open at the top flush with the charging platform. The coke and scrap are charged in large buckets handled by a heavy traveling crane. The charging operation is very simple, the buckets being merely dumped over the top of the furnace. A hole in the roof over the cupola provides for the exit of the gases. The cupola is slagged-off like a regular blast furnace, the slag notch being shown at the left in the illustration.

Economical Radiator Cores

By G. C. Olmstead

The writer has charge of a shop in which radiator cores are made, and in order to reduce the cost of these cores a number of experiments have been made, the results of which may be interesting. The cores used before the experiments were undertaken were plain mixtures of sand, oil and water. These cores, of course, were very strong, but they were also somewhat expensive.

In experimenting with the different mixtures, sample cores 1 inch square and 14 inches long were used. They were supported horizontally between two ⅜-inch rods spaced 12 inches apart. A pail was suspended from the center of the core under test and water was poured into the pail as uniformly as possible until the core broke. The weight of the pail and the water was then determined and the modulus of rupture computed according to the following formula:

$$S = 3\frac{WL}{2bd^2} \text{ in which}$$

S is the modulus of rupture, W is the breaking load and L, b and d the length, breadth and depth of the core, respectively.

These experiments were not made with scientific exactness, but the results checked fairly closely. They were sufficiently free from error for practical purposes.

The details of the experiments are given in the accompanying table. The sand was clean and of medium grain size. It was pumped from Lake Superior at Duluth.

The experiments showed that many factors affect the strength of the core. They must all be taken into consideration in making comparisons. These factors include the nature and quality of the ingredients, the time of baking, the temperature of baking, the humidity of the oven, the completeness of the mixing, etc.

In radiator work, completed molds occasionally stand for 24 hours before they are poured. In such cases, the cores must not absorb moisture. Also, the sand must not scuff or roll up while striking off, as this will make cores under size. The mixed sand should be of such a nature that it will stand for several hours without caking or drying out appreciably. The cores must vent freely and the mixture should not stick to or gum the core boxes.

Our core room practice prior to making the experiments just described was to dump out a certain number of wheelbarrow loads of sand, add a certain amount of oil and then mix in water until the batch felt right. It was found that this mixture averaged 50 parts of sand to one of oil by volume.

Our experiments led to the following conclusions:

1.—Short baking requires more oil for a given strength.

2.—Thorough mixing adds to the strength.

3.—The practice of mixing according to "feel", described above, produces good cores, although the mixture is very irregular. The modulus of rupture of such cores varies from 137 to 232, whereas from 110 to 125 is sufficient. The additional strength is unnecessary and costly.

4.—The most satisfactory mixture consists of 50 volumes of sand to one of oil, with 7 per cent moisture. The bond should consist of 75 per cent linseed oil and 25 per cent glutrin.

Details of Tests on Radiator Core Mixtures

Test No.	Ratio of mixture	Bond	Modulus of rupture	Per cent moisture (weight)	How mixed	Remarks.
1	50:1	Linseed	137.2	Unknown	Machine	Usual core room practice.
2	50:1	Linseed	84.0	Unknown	Machine	Same batch as No. 1, but tested after bars had been buried in tempered sand 20 hours.
3	Unknown	Glutrin Dextrin Gangway Sand	106.2	Unknown	Hand	Bars fell to pieces after being buried as above.
4	50:1	Linseed	232.0	Unknown	Machine	Much stronger than necessary.
5	50:1	"Linoil" and Naphtha	100.0	Unknown	Machine	Cores scuffed up in striking off core boxes.
6	50:1	Linseed	178.0	Unknown	Machine	Good firm core.
7	50:1	Linseed	184.0	1	Hand	Good firm core.
8	50:1	Linseed	247.0	4	Hand	Good firm core.
9	50:1	Linseed	179.0	8	Hand	Good firm core.
10	50:1	Linseed	189.5	Unknown	Machine	Also mixed 5 minutes in addition by hand.
11	50:1	Linseed	159.5	Unknown	Machine	Same as No. 10 without additional mixing.
12	50:1	Linseed 75 per cent Glutrin 25 per cent	150.7	4	Hand	Not thoroughly mixed. Seemed rather stiff and dry mixture.
13	50:1	Same as No. 12	219.0	7	Hand	Excellent core, stood moisture well.
14	50:1	"Peterson"	153.0	7	Hand	Sand rubbed off baked core. Stood moisture well.

In the course of our experiments it was found necessary to determine the weight of sand corresponding to various percentages of moisture. For this purpose the accompanying diagram was plotted. This diagram is also useful in determining how many pounds of water must be added to the bin sand to bring it up to the desired percentage of moisture. The quantities are arrived at as follows:

Let A = cubic feet of sand to be used.
m = per cent of moisture in the sand, determined by sampling.
m′ = the per cent of moisture desired in the sand.
w = weight of sand per cubic foot at m per cent of moisture. (Determined from curve.)
w′ = weight of sand per cubic foot at m′ per cent of moisture. (Determined from curve.)

Then,

Awm = pounds of water in the pile of sand and
Aw′m′ = pounds of water desired in the pile of sand.
Now Aw′m′ — Awm or A(w′m′ — wm) = the pounds of water to be added.

Constant factors may be substituted for any given existing conditions.

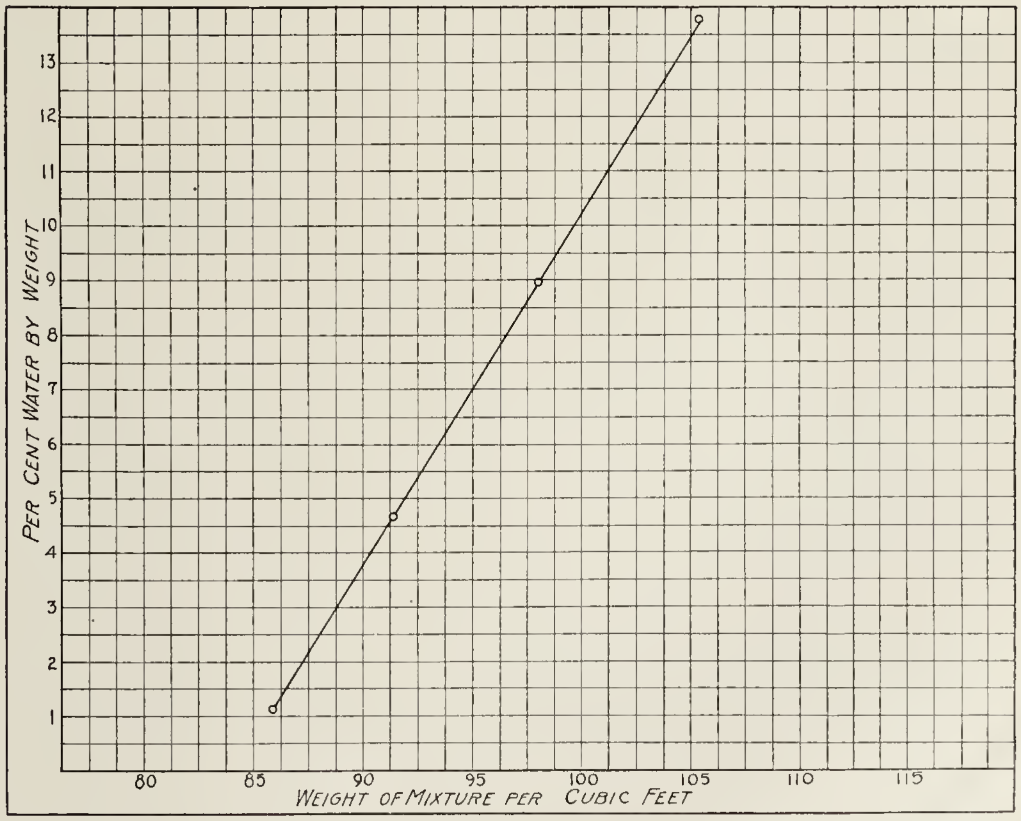


DIAGRAM SHOWING THE WEIGHT OF SAND PER CUBIC FOOT WITH VARYING PERCENTAGES OF MOISTURE

The Values Are for Rammed Sand. For Sand as Shoveled, Add 84 Per Cent of the Weights Indicated by the Diagram

THE FOUNDRY

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Contents

PAGE
REPORT OF FOUNDRYMEN'S CONVENTION.......................... 411
REPORT OF MEETINGS OF INSTITUTE OF METALS.................... 423
BOSTON FOUNDRY EXHIBIT A BIG SUCCESS......................... 427
THE EFFECTS OF SEASONING ON GRAY IRON CASTINGS............... 435
MAKING CAST IRON SHELLS IN PERMANENT MOLDS................... 439
CRAFTWORK IN THE FOUNDRY..................................... 443
CALCULATING TENSILE FROM TRANSVERSE STRENGTH................. 445
LARGE FOUNDRY TO PRODUCE TRUCK WHEELS........................ 445
TENTATIVE SPECIFICATIONS FOR BRASS CASTINGS.................. 446
PROBLEMS OF THE BRASS FOUNDER................................ 447
A NON-SHRINKABLE PATTERN ALLOY............................... 447
A CORE SAND MIXTURE FOR GLOBE VALVES......................... 447
AVOIDING CUTTING OF CORES.................................... 447
CAUSE OF FLAKING... 447
ROUGH AND DIRTY YELLOW BRASS CASTINGS........................ 448
MINUTE CAVITIES IN BRASS CASTINGS............................ 448
CLEANING BRASS CASTINGS WITH ACID............................ 448
CAN GOVERNMENT METAL BE FORGED?.............................. 448
REMOVING ALUMINUM FROM BRASS................................. 448
PRODUCING MACHINABLE MALLEABLE IRON CASTINGS................. 449
LADLE SLEEVES AND STOPPERS................................... 451
MIXTURE FOR STOVE CASTINGS................................... 452
STEEL CASTINGS FOR ORDNANCE CONSTRUCTION..................... 453
PERSONALS 455
FOUNDRYMEN SHOW INTEREST IN SAFETY PROBLEMS.................. 456
INFLUENCE OF IMPURITIES ON TENSILE STRENGTH.................. 457
ORGANIZING FOR WELFARE WORK IN FOUNDRIES..................... 458
SOLVING ELECTRIC FURNACE POWER PROBLEMS...................... 459
PREVENTING ACCIDENTS IN INDUSTRIAL YARDS..................... 461
LARGE SCRAP MELTING CUPOLA................................... 462
ECONOMICAL RADIATOR CORES.................................... 462
CONTENTS 464
CAPITALIZE YOUR CONVENTION TRIP.............................. 464
TRADE OUTLOOK 464
WHAT THE FOUNDRIES ARE DOING.................................. 467
NEW TRADE PUBLICATIONS....................................... 468

Capitalize Your Convention Trip

NOW that the 1917 convention is an event of the past, each of the three thousand foundrymen who visited Boston last week has undoubtedly returned to the daily routine more than ever determined to operate his plant in accordance with the principles which make for higher efficiency. Moreover, those who listened to the remarkable papers which were presented during the week of Sept. 24 were certainly charged with a feeling of obligation to the government to do everything in their power to increase the output of the foundry industry. It is doubtful if ever a convention of manufacturers offered more in the way of technical information, shop experience and solution of management problems than the meeting recently concluded in Boston.

On account of the tremendous work involved in arranging for such a convention and because of the difficulty in assembling thousands of foundrymen at a time when the demands of business are most pressing, such events are necessarily confined to one each year. Therefore, the foundryman who would profit most from the activities of the American Foundrymen's association and the American Institute of Metals must make use of every item of information obtained from the annual meeting. The progressive foundryman will do well to study the papers devoted to the phase of the foundry or industry in which he is interested. He will also find ample opportunity to benefit from suggestions received at the foundry and machine shop exhibition. If each foundryman sets out to capitalize his convention experience, the influence of the allied associations will be strengthened and the foundry industry will be greatly benefited.

Trade Outlook

PRICES for pig iron, scrap and other materials used in the foundry industry, which showed an upward tendency during the first three quarters of 1917, assumed indefinite values during the past month. Basic pig iron was the first to show a decline and sales of this iron at from $4 to $6 under the previous high prices were noted during September. All grades of foundry iron have exhibited a tendency toward lower prices. An improved car situation has had a good effect on the delivery of coke, although the Connellsville product still is quoted at comparatively high prices. Sales of pig iron during the past month have been confined to lots of 200 tons and less. No. 2 foundry iron is quoted in the leading centers as follows: Pittsburgh, $53.95; Chicago, $55; Cleveland, $54 to $55; Buffalo, $53 to $54; Philadelphia, $50.50 to $53.50; and Birmingham, $47 to $50. Bessemer is held at $51, valley, and basic is quoted at $42 to $46, valley. Malleable iron is quoted at $55, Chicago, and Lake Superior charcoal iron is selling at from $59 to $62.

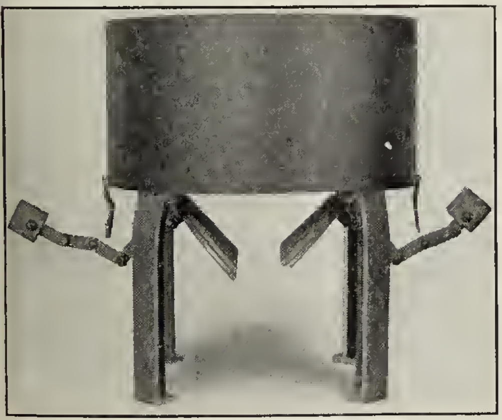
Counter-Balanced Cupola Doors

The accompanying illustration showing counter-balanced cupola bottom doors is almost self-explanatory. The weights and their connecting links are so arranged that they may be adjusted to hold the doors in equilibrium at an angle of approximately 45 degrees. When so adjusted, the doors may easily be closed by one laborer. The arrangement of the counterweights is such that it is unnecessary for the laborer to work underneath the cupola while the doors are being closed. After they have been shut by pushing on the counterweights, however, the man may put the props in place without danger.

When the props are knocked from under the doors preparatory to emptying the cupola, the weights prevent the doors from swinging back and being damaged by knocking against the cupola supports. Also since the doors remain partially closed, the splashing of molten slag is considerably reduced. The doors may be fastened wide open by means of the latches shown in the illustration. This new device is being manufactured by the Federal Foundry Supply Co., Cleveland.

A Complete Sand-Blasting Room

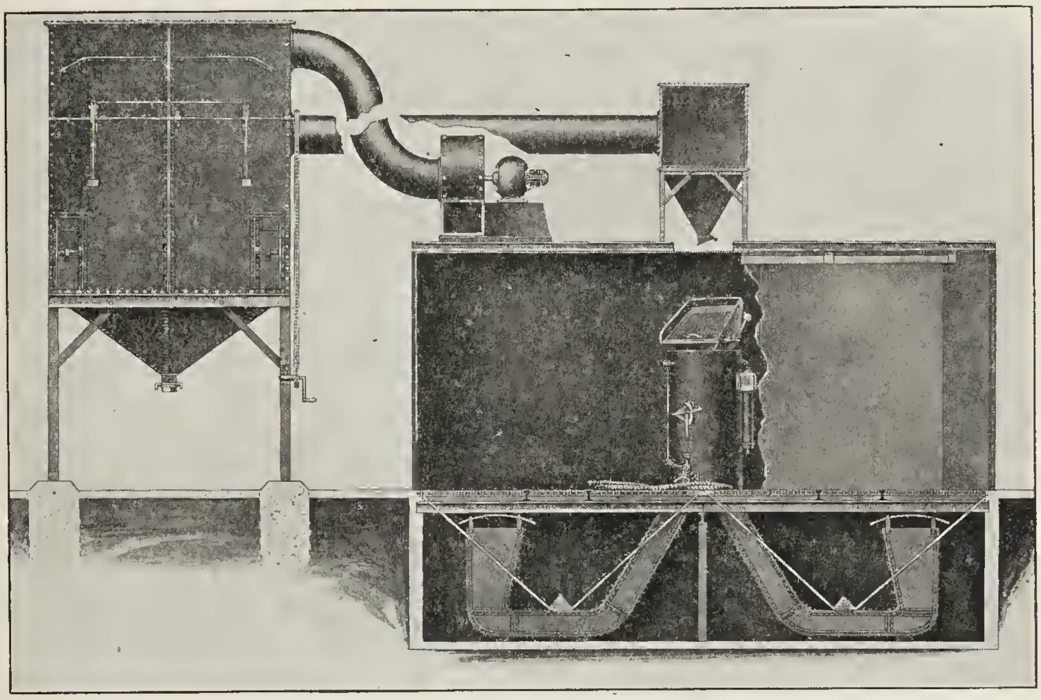
An unusually complete sand-blast installation consisting of a double sand-blast room, sand-blast machine, sand elevating pipe, sand-separator, steel-case cloth type dust arrester and exhaust fan with direct motor drive, built by the Illinois Mfg. & Supply Co., Quincy, Ill., is shown in the accompanying illustration. The operator works in one of the two rooms with the door closed while his helper fills the open room with the castings to be cleaned. In this way this double sand-blast room doubles the output of cleaned castings, over a single room, since the operator never is compelled to stop sand-blasting while removing castings from the room and charging others to be cleaned. When he has finished sand-blasting the castings in one room he enters the other room which has been filled with castings by his helper and proceeds to clean these. A sliding door separates the two rooms. In this illustration the partition between the rooms is not shown.


COUNTERBALANCED CUPOLA DOORS SAVE LABOR AND TIME

While cleaning castings, the sand, after having served its purpose, falls through a floor grating and through the heavy iron screen directly underneath the floor which prevents nails, wire, fins, etc., from falling onto the intake pipe. As a further precaution against blocking the end elevating pipe, a revolvable cinder screen is placed directly over the intake pipe thereby insuring a free, continuous flow of sand while operating. When the sand enters the intake pipe it is carried by suction into the sand separator where the sharp cutting sand is separated from the dust in three compartments, thereby dividing the sand into coarse, medium and fine.

Air enters the sand-blast room through perforated plates which form its top, the air traveling downwards approximately 40 to 50 feet per minute, thereby drawing the dust away from the operator's head. This system is so regulated that the air is changed in the room from five to seven times per minute. The air suction is created by the exhaust fan which exhausts the air from the dust arrester, thereby filtering all fine dust from the air and it is discharged by the fan into the building free from dust.

The casing of the dust arrester is filled with a series of cloth screens, suspended at the top in an angle frame attached to the side of the casting. The cloth screens are tapered, being wide at the top and narrow at the bottom. When the rapping mechanism is employed, the hammers strike the rapping bars, one of which is attached to either side of each screen, and since these are tapered and suspended at the top satisfactory vibration of the screens is provided, the dust falling when they are jarred and, therefore, the pores of the cloth are effectively kept open and the fine dust does not cake on the face of the screens. This particular construction is essential to prevent retarding the air suction. Entrance doors are provided on either side of the dust arrester casing.


DOUBLE SAND-BLAST ROOM AND COMPLETE SAND-BLAST CLEANING EQUIPMENT, BUILT BY THE ILLINOIS MFG. & SUPPLY CO.

New Form of Safety Glass

A new form of safety glass has recently been developed by a New York firm. The lens, in the case of a goggle, consists of two layers of optical glass, which may be plain or curved, with a layer of celluloid between. The whole, it is stated, is welded into a solid mass. This combination is said to possess the strength and safety features of celluloid, combined with the advantages of glass. The glass is manufactured by Strauss & Buegeleisen, 37 Warren street, New York.

The Evase stack for creating draft in furnaces is finding increasing application in foreign countries. The process consists in blowing air into a chimney which is contracted to a vase-like shape at the point at which the air is liberated. Its principle of operation is that of an injector, and the fan draws its air from the lower part of the chimney and discharges it at the contracted point higher up. It eliminates the necessity for building high chimneys, and when applied to brass melting chimneys gives all the advantages of natural draft combined with speed of melting.

Employs Auxiliary Electrode

An auxiliary electrode, in addition to the one, two or three main vertical electrodes, the number dependent upon whether the furnace is to operate on single, 2 or 3-phase power, is a distinctive feature of the newly designed electric furnaces made by the Booth-Hall Co., Chicago. The auxiliary electrode is inserted vertically through the roof except in the small furnaces, where it is projected diagonally through the door. The furnaces also are provided with wrought iron grids which are embedded in the hearth, with a refractory facing.

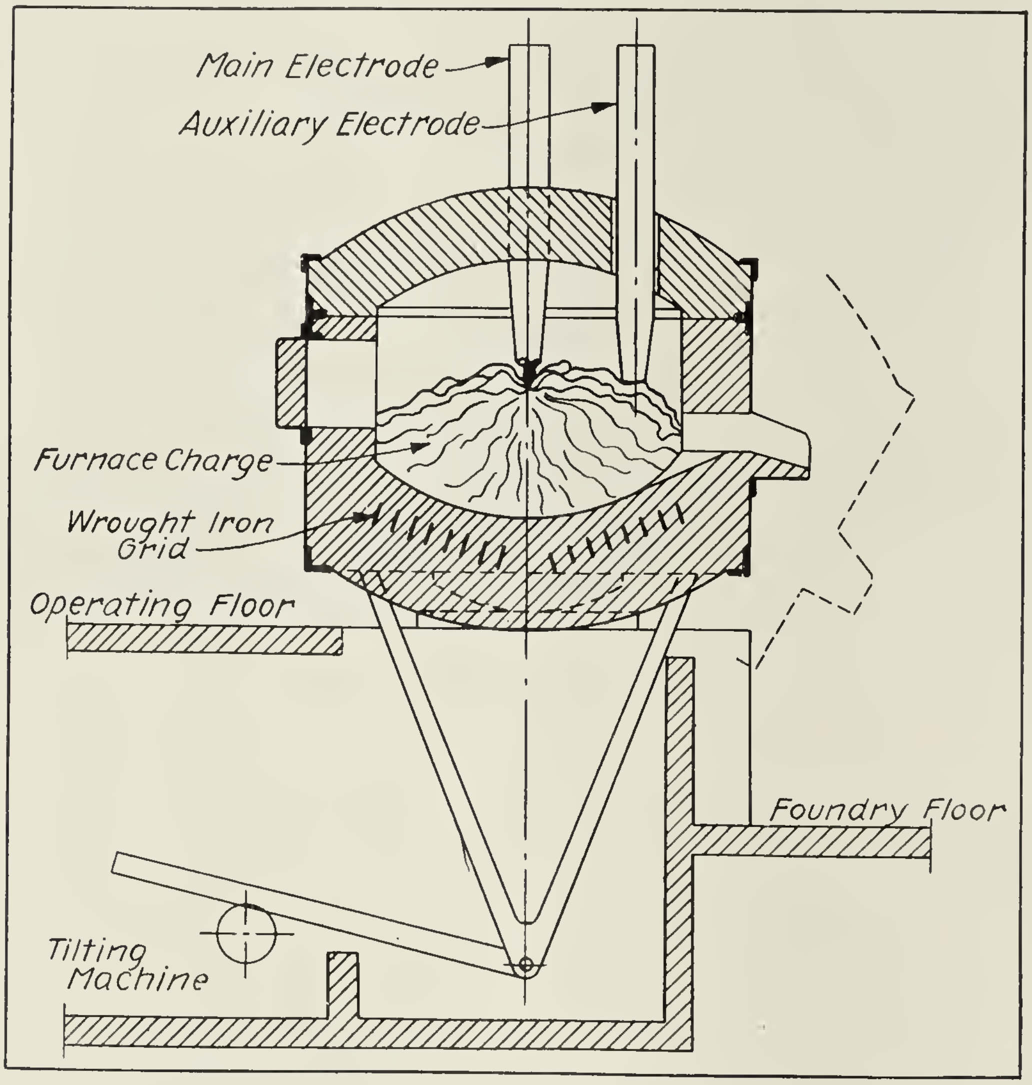


DIAGRAM SHOWING AUXILIARY ELECTRODE RESTING ON SCRAP AND ARCS DRAWN WITH MAIN ELECTRODES

In starting a heat with a cold charge, for example, in a 2-phase furnace, a pawl on the auxiliary electrode holder is released, permitting the secondary electrode to rest upon the charge of scrap. Arcs are then drawn with the two main electrodes and the metal begins to melt under the heat of the arcs. The auxiliary electrode acts as a common neutral, no arc being drawn and consequently no metal is melted under the auxiliary. When a molten bath has accumulated upon the hearth in sufficient volume to make the hearth conductive of current, ammeters indicate the flow of current through the grids and the auxiliary is withdrawn from the furnace and its port is closed. The furnace continues to operate with the current entering through the main vertical electrodes, being carried through the bath and the hearth to grids, passing out through the grids. The transformer connections are so arranged that each phase has a separate circuit.

Use of Auxiliary Electrodes

It is pointed out by the makers that the use of the auxiliary electrode assures a contact with the charge when the heat is being started and that there is no bottom contact touching the bath that may be covered with slag. This system of electrodes also precludes the possibility of arcs in series above the bath. Water-cooled contacts are eliminated in this furnace.

The accompanying illustration shows a general diagram of the furnace with the auxiliary resting upon the scrap. It is to be noted that by having two main electrodes and an auxiliary acting as a common neutral, it is possible to sinter in the hearth, layer by layer, thus producing a monolithic mass providing a durable bottom lining. The furnace is tilted by an arrangement of rockers, steel struts and reduction gears. The rockers are so designed that falling material does not drop on the guides to interfere with the tilt. The furnace may be rocked backward as well as forward so that it is possible to bring the slag line flush with the door, from which the slag is tapped. The tilting mechanism is placed below the floor, where it is covered and protected. Handwheels are provided for the operation of the electrodes in the event of an accident befalling the regulating device.

The Booth-Hall furnaces are built in sizes ranging from one-quarter to 10 tons for 1, 2 or 3-phase power. Smaller sizes generally are confined to single-phase operation, while the 8 and 10-ton sizes are built only for 3-phase power. Two-phase furnaces are used with Scott-connected transformers to balance evenly the loads on the 3-phase supply lines.

Trade Notes

The Pangborn Corp., Hagerstown, Md., has purchased the sand blast department of the Curtis Pneumatic Machinery Co., St. Louis. A complete line of machines will be carried in stock including repairs parts.

Foundrymen of Indianapolis have organized an association to promote their general welfare. The directors of the organization are: Arthur R. Baxter, William H. Holmes, Harry D. Kamp Jr., F. S. Robinson and H. L. Waterbury.

During the past few weeks the Abell-Howe Co., Chicago, sold more than 250 detachable tongue trucks, the orders largely covering complete plant equipment and included contracts from the following concerns: Saginaw Malleable Iron Co., Saginaw, Mich.; Chicago Malleable Iron Co., Chicago; American Radiator Co., Buffalo, and the Rockford Malleable Iron Co., Rockford, Ill.

The American and Foreign Sales Corporation has been organized at Washington, D. C., for the purpose of rendering service for large manufacturers who want personal representation before the government and in this way a similar service also will be rendered to the various branches of the United States government. The officers of this company follow: John L. Newbold, president; Ross P. Andrews, vice president; E. E. Thompson, secretary and treasurer, and Louis C. Witkowski, sales manager.

Welfare Work in Foundries

(*Concluded from page* 458)

a part of the gardens at the Pittsfield works of the General Electric Co. Three hundred gardens were assigned, each 50 x 100 feet. Each gardener signed an agreement stating that he would take proper care of his garden. It was necessary to build 800 feet of temporary fence and run 1000 feet of water pipe line into the property. A "raising bee" was therefore held one Saturday afternoon, the company supplying old lumber and pipe. It took just 40 minutes to complete the work. Care has been taken to check these 300 plots and with the exception of one employe who was dropped, every one has remained with the company and taken good care of his plot.

Coal the past winter was difficult to secure and the price was high. Some companies have tried the experiment of co-operating with their employes in selling coal at cost. At the Pittsfield works, a coal club was formed and 2000 tons were sold at cost. In securing the coal about one-half of the coal was purchased at a low figure and the other half was secured at a somewhat higher figure as it was purchased on a rising market. Nevertheless, the employes supported the proposition exceedingly well. Many of the other forms of work are desirable and the men are generally interested in them, but they exert a holding influence to a lesser degree than the grouping discussed.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Geronimo Motor Co., Enid, Okla., contemplates the erection of a malleable foundry using gas fuel.

The West Bend Aluminum Co., West Bend, Wis., will build a plant and warehouse, respectively 70 x 140 feet and 50 x 60 feet.

Plans have been prepared for a 50 x 100-foot foundry to be erected for the Enterprise Brass Works, Muskegon, Mich.

The Jaeschke Bros. Foundry Co., Milwaukee, has awarded a contract for a concrete sand storage building, 65 x 28 feet.

A foundry addition is being erected by the West Michigan Steel Foundry Co., Muskegon, Mich.

The Bramcote Foundry & Machine Co., Pottstown, Pa., is building a machine shop, 120 x 148 feet and a core room, 24 x 40 feet.

The Trenton Malleable Iron Co., Trenton, N. J., will build a carpenter and pattern shop, two stories, 30 x 128 feet.

The Gray Iron Castings Co., 247 Habaugh street, Detroit, will erect a $10,000 plant, 30 x 48 feet.

The Waterloo Engineering Co., Waterloo, Ia., contemplates the erection of a 150 x 600-foot foundry at a cost of $200,000.

The Aluminum Castings Co., 1576 Joseph Campau avenue, Detroit, is erecting a one-story addition to its machine shop.

A one-story foundry will be built by the Bayonne Steel Casting Co., Bayonne, N. J., at a cost of $10,000.

H. T. Hornsby, Springfield, Mo., has acquired a three-acre site in Baxter Springs, Kans., and will erect a $60,000 foundry.

De Mattia Bros., Inc., Garfield, N. J., will erect a one-story foundry, 70 x 80 feet, at a cost of $9000.

The Fulton Foundry & Mfg. Co., Cleveland, has acquired the Fulton Foundry Co. No changes were made in the management.

The Peru Foundry Co., Peru, Ind., has been incorporated with $60,000 capital by M. F. Gartland, J. H. Schaumleffel and Harry J. Schaumleffel.

The Valley City Machinery Co., Grand Rapids, Mich., has purchased the plant of the Sintz Engine Co., which it will remodel into a foundry.

The Compton & Knowles Loom Works, Worcester, Mass., has awarded the contract for the erection of a two-story, 126 x 277-foot addition to its foundry to cost $15,000.

The Hesse-Martin Iron Works, 434 Belmont street, Portland, Oreg., is erecting a foundry and machine shop at a cost of $100,000.

The Hedges Boiler Works, Mobile, Ala., will build a machine shop, 48 x 40 feet; a foundry, 30 x 60 feet, and a blacksmith shop, 60 x 60 feet.

The Aurora Foundry Co., Seattle, Wash., is building a plant at Occidental avenue and Horton street for the production of iron and steel castings.

The Westinghouse Electric & Mfg. Co., East Pittsburgh, will erect a $40,000 foundry, 165 x 241 feet and a $12,000 machine shop at its Cleveland plant.

A permit has been obtained by the Grabler Mfg. Co., Cleveland, to build a 1-story, 66 x 104-foot foundry at a cost of approximately $25,000.

Contracts have been awarded for the erection of a one-story, 35 x 45-foot foundry and cleaning shed addition to the plant of the Riverside Steel Casting Co., Newark, N. J.

An addition is being erected to the plant of the Lakey Foundry & Machine Co., Muskegon, Mich. This extension will triple the capacity of the plant.

Contract has been let for the erection of a brick, 1-story, 50 x 57-foot foundry for the Coppus Engineering & Equipment Co., Worcester, Mass.

Plans have been completed for the erection of a 65 x 132-foot addition to the plant of the Fulton Brass Foundry Co., South Bend, Ind.

The International Castings Co., Rome, Ga., has been incorporated to engage in the manufacture of stoves, ranges, etc. The company is capitalized at $10,000 by W. A. Smith, E. W. Kreider and others.

The Palmer Foundry & Machine Co., Palmer, Mass., has been incorporated with $15,000 capital, by Michael A. Henebery, William A. Scollen and William C. Mellish, all of Worcester, Mass.

The new plant of the American Machine & Mfg. Co., Atlanta, Ga., will be placed in operation early in September. It is equipped with an acid open-hearth furnace and will have a capacity of 10 tons of castings daily.

Contract has been awarded by the National Malleable Castings Co., Cleveland, for a one-story, 61 x 150-foot pattern shop to be erected next to the large foundry now being built at Quincy avenue S. E. and Woodhill road.

The Williams Foundry & Machine Co., Akron, O., has increased its capital stock and is being reorganized. A three-story, 50 x 275-foot addition will be erected and considerable new equipment installed.

The Bowen Anchor Co., Morton, Pa., is building a 90 x 250-foot foundry which it expects to have in operation about Dec. 1. The equipment includes a 20-ton acid open-hearth furnace.

Hendley & Whittemore, Beloit, Wis., have awarded a contract for the erection of a brick and steel addition, 60 x 125 feet. The company operates a foundry and machine shop.

The T. L. Smith Co., Milwaukee, manufacturer of cement mixing machinery, has purchased the plant of the Wisconsin Foundry Co. of the same city and will continue to operate it as a department of its business.

The Beatty Mfg. Co., recently incorporated with $250,000 capital, has purchased four acres at Hammond, Ind., and will build a steel foundry and shop for the manufacture of heavy machinery at a cost of $50,000.

The Eagan-Rogers Steel & Iron Co., Crum Lynne, Pa., is building additions which will practically double the capacity of its plant. The company has a large order for small castings for the United States government.

The Runyon Corp., New York, has been organized with a capital stock of $25,000 to engage in the operation of a foundry and machine shop. A. W. Britton, S. B. Howard and G. V. Reilly, 65 Cedar street, are the incorporators.

A contract has been let by the Millbury Steel Foundry Co., Millbury, Mass., for a one-story, 50 x 64-foot addition to its foundry and a one-story, 30 x 120-foot pattern storage and office building. The company is installing a heroult electric steel furnace.

The American Mfg. Co., Meriden, Conn., has been capitalized at $50,000 to engage in the manufacture of castings and other metal goods. F. E. Demers, David J. Murphy, O. S. Montambault, all of Waterbury, Conn., are the incorporators.

The Fruit Machinery Co., Belleville, Ont., has been incorporated to conduct a foundry and machine shop business with $40,000 capital stock. The incorporators are Robert J.

Graham, Frank B. Foley, George K. Graham and Jamieson Bone.

A steel and concrete, two-story factory building, 60 x 94 feet, is being erected for the Cope Pattern Works at Wight & McDougall avenue, Detroit. The company expects to remove from its present shop to the new plant about Oct. 15.

A foundry, 75 x 100 feet, will be built at Fulton and Curtis streets, Chicago, for H. G. Lang, 162 North May street, that city. The cost will approximate $15,000. The architect is R. T. Newberry, 208 South La Salle street, Chicago.

The Durbin Automatic Train Pipe Connector Co., 306 Pontiac building, St. Louis, will build a malleable foundry of 20 tons daily capacity. The company manufactures flexible pipe joints and conducts a jobbing business.

The Twentieth Century Brass Works has purchased for $25,000, the assets of the M. H. Foundry & Mfg. Co., Belleville, Ill.; consisting of patents, patterns and the entire plant and equipment. The new company will continue the manufacture of plumbing specialties and brass castings in addition to conducting a general machine shop business. William Arlhoff is president; Walter J. Ruediger, vice president and E. E. Wangelin, secretary, treasurer and general manager.

The Wehr Steel Co., Milwaukee, has awarded contracts for the erection of additions to its plant, which include two 80-foot bays costing $20,000 without equipment. When these extensions are completed the capacity will be increased from 300 to 400 tons of converter steel per month.

The firm name of the Framingham Machine Works, Framingham, Mass., has been changed to the Framingham Foundries to define more clearly the line of work in which the company is engaged. The plant recently has been re-equipped with machinery and appliances for the production of gray iron castings and the galvanizing of metal goods.

The Oshkosh Foundry Co., Oshkosh, Wis., has been incorporated with $10,000 capital to engage in the manufacture of gray iron castings. The plant is built and the equipment has been purchased. H. M. Steuck is president; F. T. Turner, vice president and J. W. Radl, secretary and treasurer.

NEW TRADE PUBLICATIONS

PNEUMATIC EQUIPMENT.—The Ingersoll-Rand Co., New York, recently has issued a 20-page catalog devoted to motor hoists and stationary motors; a 4-page bulletin describing a coal pick and core breaker; a 16-page booklet devoted to pneumatic chipping, calking and scaling hammers and an 8-page bulletin describing air receivers, pressure tanks and moisture traps. All of these publications are well illustrated and include tables of sizes and capacities.

ENCLOSED LEVER SWITCHES.—"Safety first" combined lever switches and fuses are illustrated and described in a bulletin recently issued by the General Electric Co., Schenectady, N. Y. The important features of these switches follow: The current carrying parts are completely enclosed and are inaccessible while alive; the switches can be locked in the "off" position and the fuse chamber can be locked to prevent access by unauthorized persons without interfering with the operation of the switch.

SOLVAY ALKALI.—In a 56-page catalog issued by the Solvay Process Co., Syracuse, N. Y., the various forms and uses of alkali are described and notes on alkalimentry are furnished. Chemical and commercial tables are presented and conveniently arranged for the use of the consumer. The products manufactured include soda ash, caustic soda, bicarbonate of soda, and allied products. The soda process is outlined and the uses of the various products are discussed in detail. A large number of views of the plants of the Solvay Process Co. are included.

SPEED REGULATING PANELS. — Designed for use with motor-operated feed water pumps for boilers, gas blowers, mechanical stokers, blowers, etc., pressure - controlled speed regulating panels with automatic pressure regulator, as described in a bulletin issued by the General Electric Co., Schenectady, N. Y., provide a convenient means of controlling the speed of a motor where changes in air or liquid pressure automatically vary the speed. If the pressure runs above or drops below that for which the regulator is adjusted, the motor is automatically retarded or speeded up until the pressure is again constant.

GRINDING AND POLISHING MACHINERY.—A loose-leaf catalog, devoted to the extensive line of grinding and polishing machinery manufactured by the Webster & Parks Tool Co., Springfield, O., recently has been issued. Machines of the ball-bearing and plain-bearing types are built including floor grinders, bench grinders, grinding and polishing machines, wet tool grinders, ring-wheel end grinders, special plate edge grinders, electrically driven grinders, etc. In addition, numerous safety devices are illustrated including wheel guards and similar equipment. An extensive line of polishing and buffing lathes also is shown. The catalog is unusually well-illustrated and contains the necessary specifications covering the sizes and capacities of all of these machines.

MONORAIL HOISTS.—A 32-page bulletin, issued by the Sprague Electric Works of the General Electric Co., New York City, is devoted to the extensive line of cage controlled monorail hoists built by this company. These hoists operate on I-beam tracks, travel at a high rate of speed and can go anywhere that the single I-beam runway can be supported. These hoists are equipped with swivel trucks, enabling them to run around sharp curves so that with a properly designed runway system, with switches, turntables, etc., the hoists are able to pass one another and to convey their respective loads to their destinations without the delay caused by the traveling crane which usually occupies its entire runway. The bulletin is unusually well-illustrated with service views of these hoists in operation in various industrial plants. Monorails in casting plants are shown conveying hot metal, handling molding sand, handling a grab bucket, etc.

VOLUTE CENTRIFUGAL PUMPS. — A 36-page catalog, issued by the Worthington Pump & Machinery Corp., New York, illustrates and describes the extensive line of volute centrifugal pumps built by this company. These are constructed in three standard designs, namely single side suction type, double-suction solid case type and double-suction pump with horizontally split casing. These pumps are shown both direct-connected and belt-driven. A number of installation views also are included.

SAND-BLAST EQUIPMENT.—The extensive line of sand-blast machines built by the Hoevel Mfg. Co., New York City, is illustrated and described in a recently-issued 20-page catalog. Among the simpler machines built by this company are included a hose sand-blast and a machine with a stationary nozzle. Different types of revolving barrel machines are illustrated as well as several styles of rotary table sand-blast machines. A sand-blast machine adapted to the cleaning of long and flat pieces such as radiator loops, pipes, columns, plates, etc., also is shown. It is provided with two tables which operate in opposite directions. In addition to a sand-blast cabinet, a large sand-blast room is illustrated, as well as a large capacity room which is equipped with a track and turntable for the handling of trucks containing castings to be cleaned. A sand-blast room provided with a rotary floor also is shown and described, where table does not rotate continuously, but only at intervals and when desired. This rotary floor greatly facilitates the cleaning of castings and materially increases the capacity of the room. Numerous service views are included, one showing two rooms with rotary floors, one room with a track and turntable and the other illustrates Hoevel sand-blast equipment in a foundry, consisting of a sand-blast room, rotary table machine and a revolving barrel machine.

PATTERN SHOP MACHINERY. — An unusually complete catalog devoted to woodworking machinery, containing 304 pages, has been issued by the Oliver Machinery Co., Grand Rapids, Mich. Practically all of the tools essential to the modern pattern shop are illustrated and described in detail. Considerable space is devoted to the universal wood milling machine which is to the patternmaker and his department what the universal milling machine is to the tool room. This machine is furnished with either motor or belt drive. A large number of detail illustrations are included showing the various operations which it can perform and samples of work also are shown including spiral, spur and worm gear patterns. This machine also is unusually well adapted to the production of core boxes and many specimens of the most intricate nature are illustrated. A wide variety of saws for pattern shop use also are shown. A combination pattern lathe with a 90-inch swing and furnished with any length of bed is introduced to the trade by this catalog. This tool combines the functions of ordinary turning with those of turning large diameter, long cylindrical pattern gearing, etc. Its movable carriage and tool post admits of performing an infinite variety of work. The alignment of the pillar is accomplised by loose keys which fit the various slots in the plate and it may be adjusted to operate upon the larger diameters or set directly underneath the center of the spindles to act as a bed for hand turning on small work. A patternmaker's gap lathe, also illustrated, is the result of a demand for a machine of large capacity which will occupy a minimum amount of floor space when engaging it on work of medium dimensions. The bed construction is in two sections, the upper being fitted to the lower in a dovetailed slide and is moved either by hand-wheel rack and pinion or by power, to and from the headstock to close and open the gap, by means of gearing that engages the rack on its lower side. A large number of safety devices also is shown, as well as patternmakers' supplies and small equipment.

The FOUNDRY
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How Automobile Motor Castings Are Molded

A Description of the Molding Methods Employed by the Ferro Machine & Foundry Co.—Core Assembly in Mold is Unique

THE quantity production of automobile cylinders, after Winton, Haynes and Olds first introduced their horseless carriages, resulted from the efforts of a few progressive founders who failed to heed the advice of those who said, "It can't be done". From the time of the casting of the first horizontal-opposed, 2-cylinder engine this deadly incubus has stood at attention, ready to block every move the progressive foundryman might make or to deride any radical change in design suggested by automobile engineers. However, nothing succeeds like success, and today the many foundrymen in the motor car field seem willing to try any new scheme that promises an increase in quality or production regardless of the absence of precedent. When the motor vehicle first became a commercial possibility, a gang of skilled molders were proud of a day's output of three engine castings. The cores were made laboriously by hand in boxes that had been accepted by the industry as standard for generations. Today, 50, 70 and on some jobs 100 molds requiring greatly increased skill and much more labor are not considered unusual for a day's work. Expediency and accuracy in coremaking have developed at an equal pace. New machinery, improved methods of handling materials and labor-saving devices have played an important part in the wonderful growth and development of this highly specialized branch of the foundry industry. Automobile engine molds are steadily becoming more complicated. The simple 2 or 4-cylinder mold was first on the scene. Soon crank cases were added; then sixes, eights and twelves came in quick succession. A 12-cylinder mold including the crank case is the last word at present in automobile engine molding and casting in the foundry.

Perhaps no one factor has had more influence upon this particular branch of the industry than the general recognition of the skilled engineer as essential to the advance of foundry practice. To the technically trained man belongs a large share of the credit for the development of standardized methods of quantity production and for the inauguration of new machinery and devices to economize labor and to secure accuracy. The foundry of the Ferro Machine & Foundry Co., Cleveland, affords an unusual demonstration of results of the development of new ideas and the improvement of old theories of foundry practice. In the core rooms of this plant, which were described in the July number of THE FOUNDRY, the evidence of intensive standardized production is clearly discernible. Ideal foundry operation is theoretically, a comparatively simple problem if but one particular casting is to be produced. However, when some 30 separate jobs must be handled in one foundry, the problem becomes more difficult. The wide variation that exists between the molding and core-

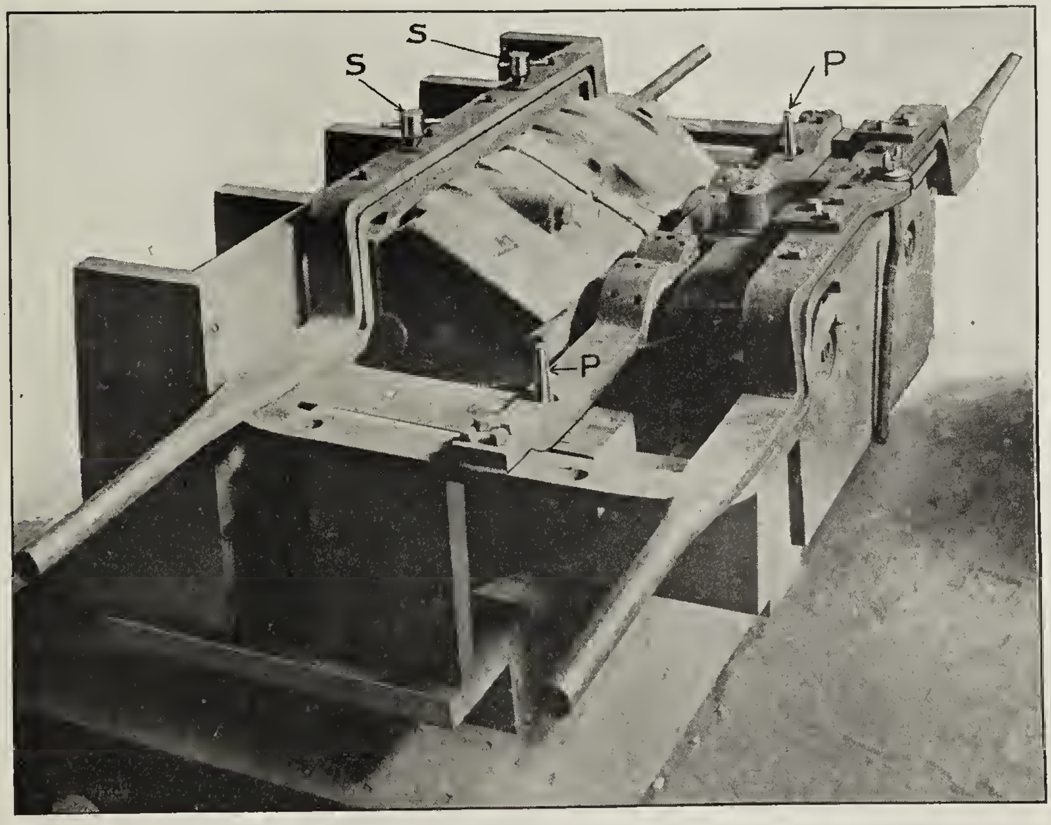


FIG. 1—ASSEMBLED CORES READY TO BE PLACED IN THE DRAG—THE SCREWS *SS* SCREW INTO ARBORS IN THE CRANK-CASE CORE

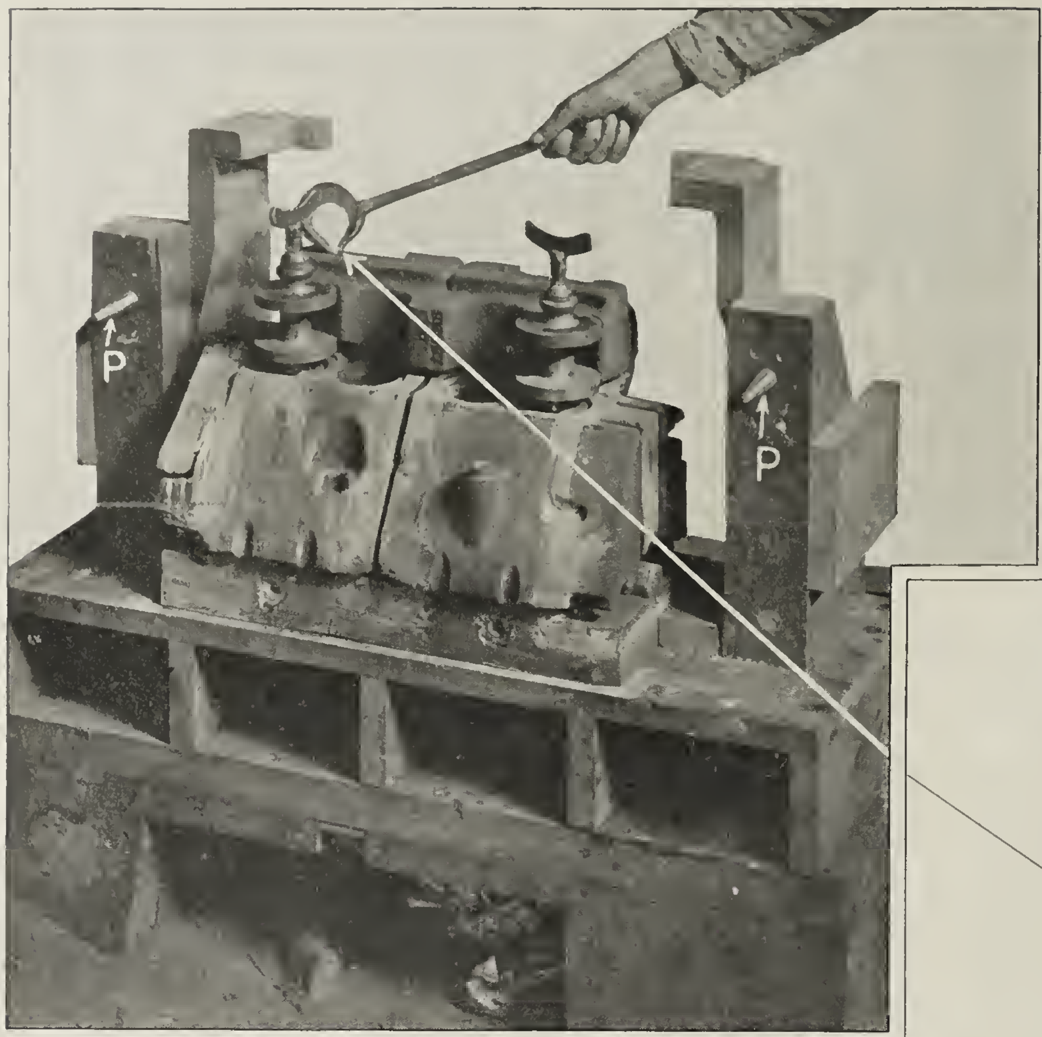


FIG. 2—LEADING THE SPRING-HOUSING CORE TO THE CRANK-CASE CORE, AN EARLY STEP IN THE CORE ASSEMBLY

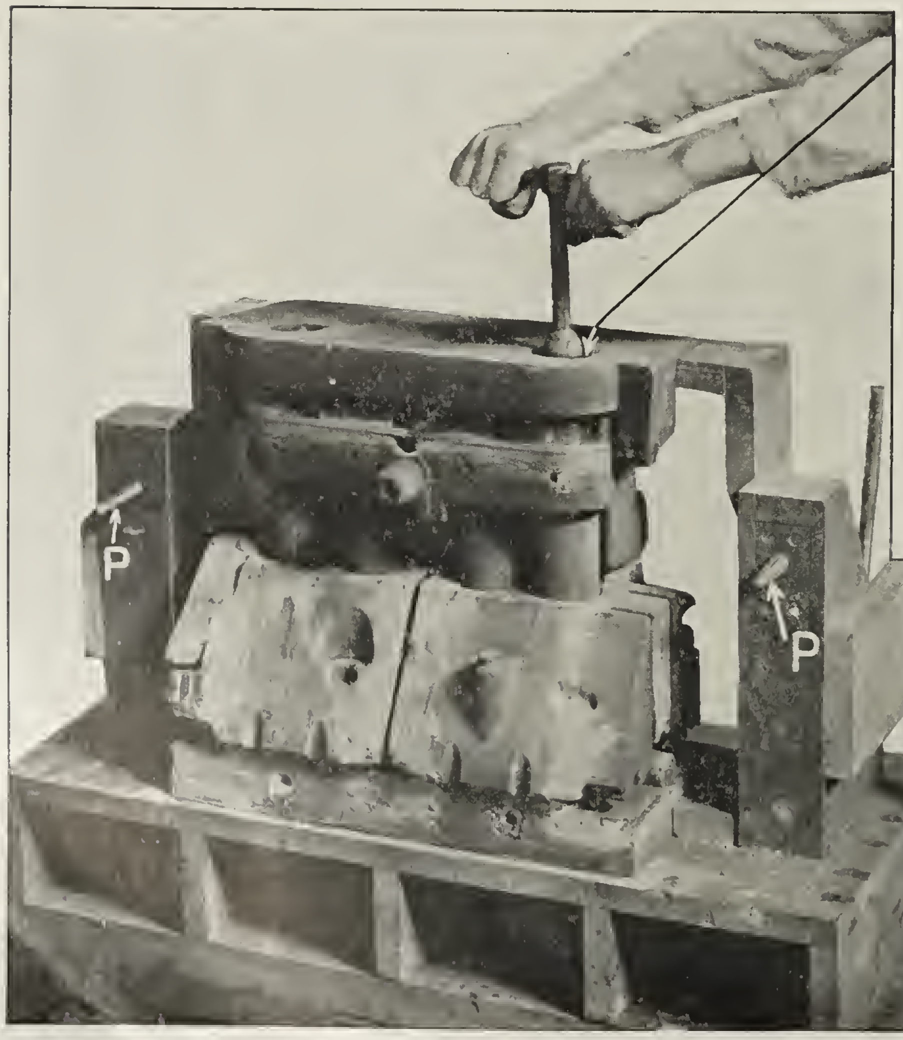


FIG. 3—THE COMPLETELY ASSEMBLED CORES ARE HELD RIGIDLY TOGETHER BY MEANS OF TWO BOLTS PASSING THROUGH THE END BARREL

making operations for a 1-cylinder mo torcycle engine and those necessar for a submarine-chaser motor indicate fairly well the nature of the work don in the foundry of the Ferro plant.

The foundry is divided into fou main sections which are devoted t the production of motor castings o various sizes and of miscellaneou pieces such as bell housings, pum cases, cylinder heads and transmissio cases. All automobile engine casting are made on the main floor in th west, east and south bays. Part o the miscellaneous work is handled i the east bay; the remainder is molde and cast on the floor above. The molding floors are divided into units each equipped to mold but one job. These individual floors are supplied with roll-over, jar-ram cope and drag molding machines, assembling jigs and other equipment to produce the particular mold to which the unit is devoted. A view of the main molding floor in the west bay where a number of different types of automobile engines are molded is shown in Fig. 5. This illustration also shows the arrangement of the service cranes

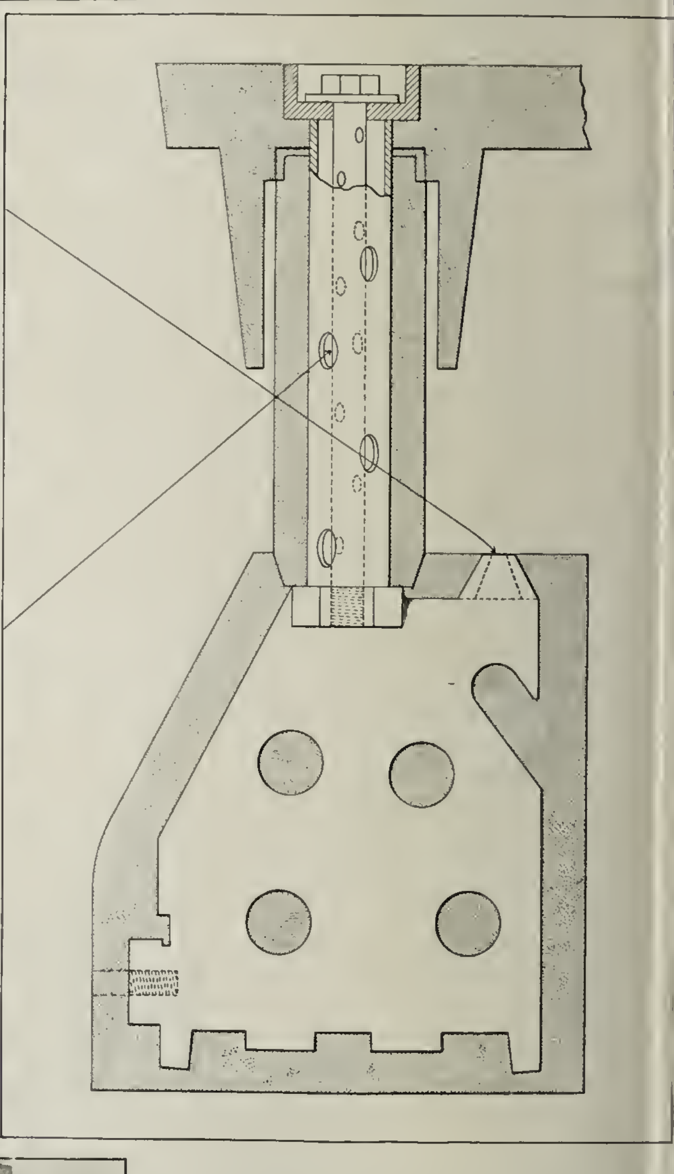
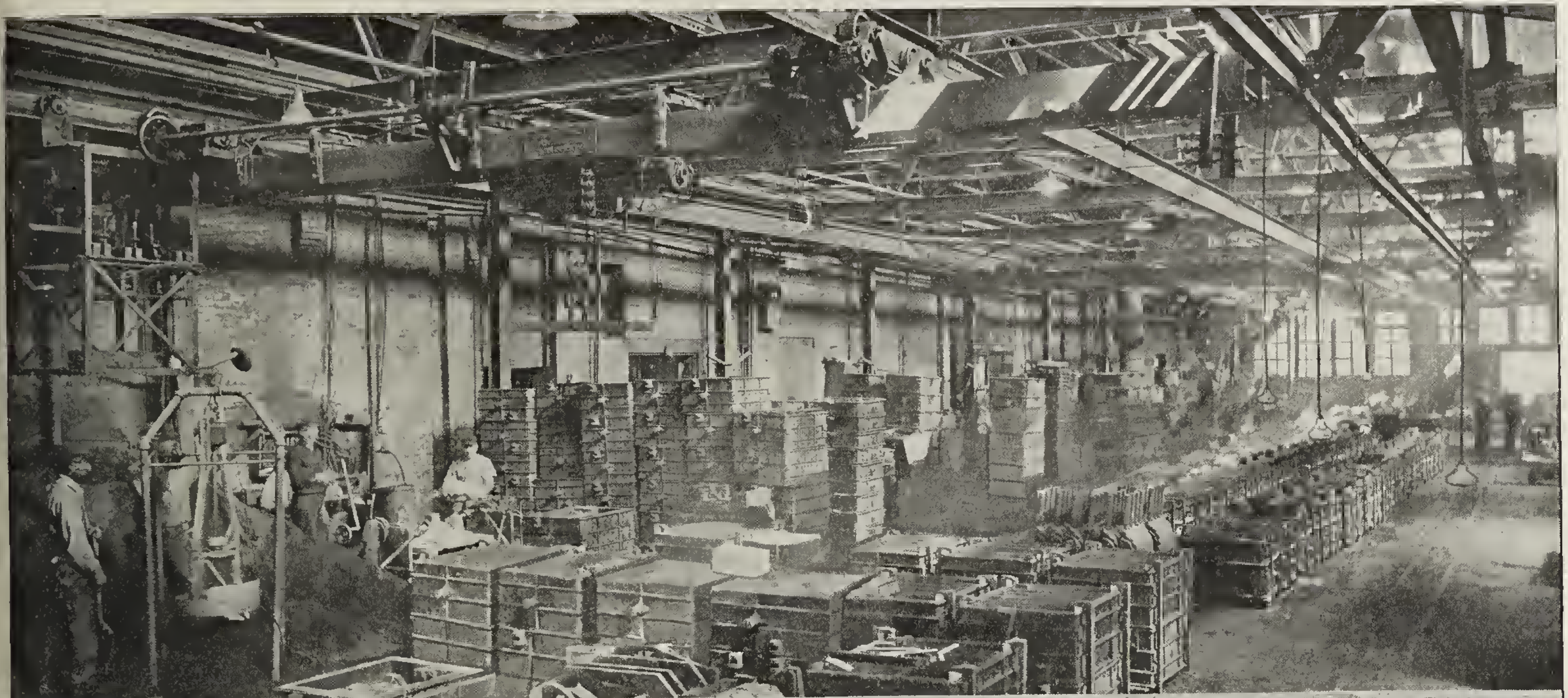
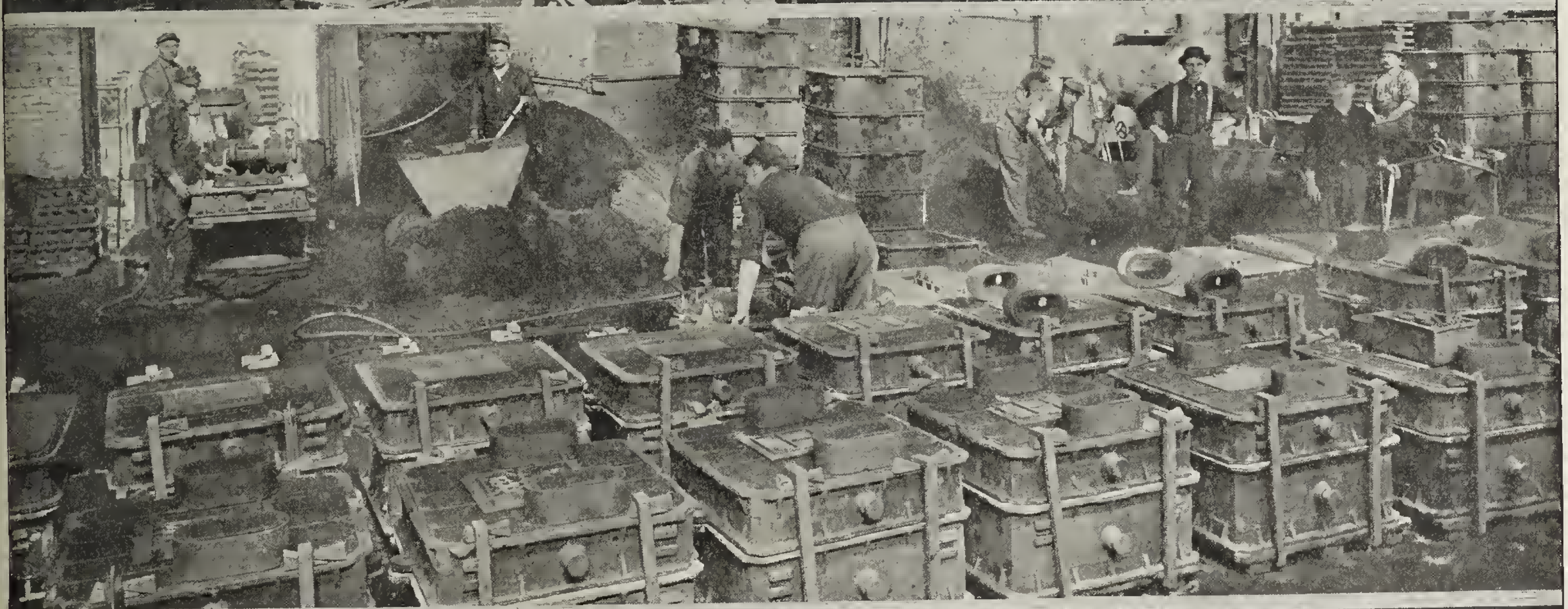


FIG. 4—DETAIL SHOWING HOW THE ARBORS ARE PLACED IN THE CORES





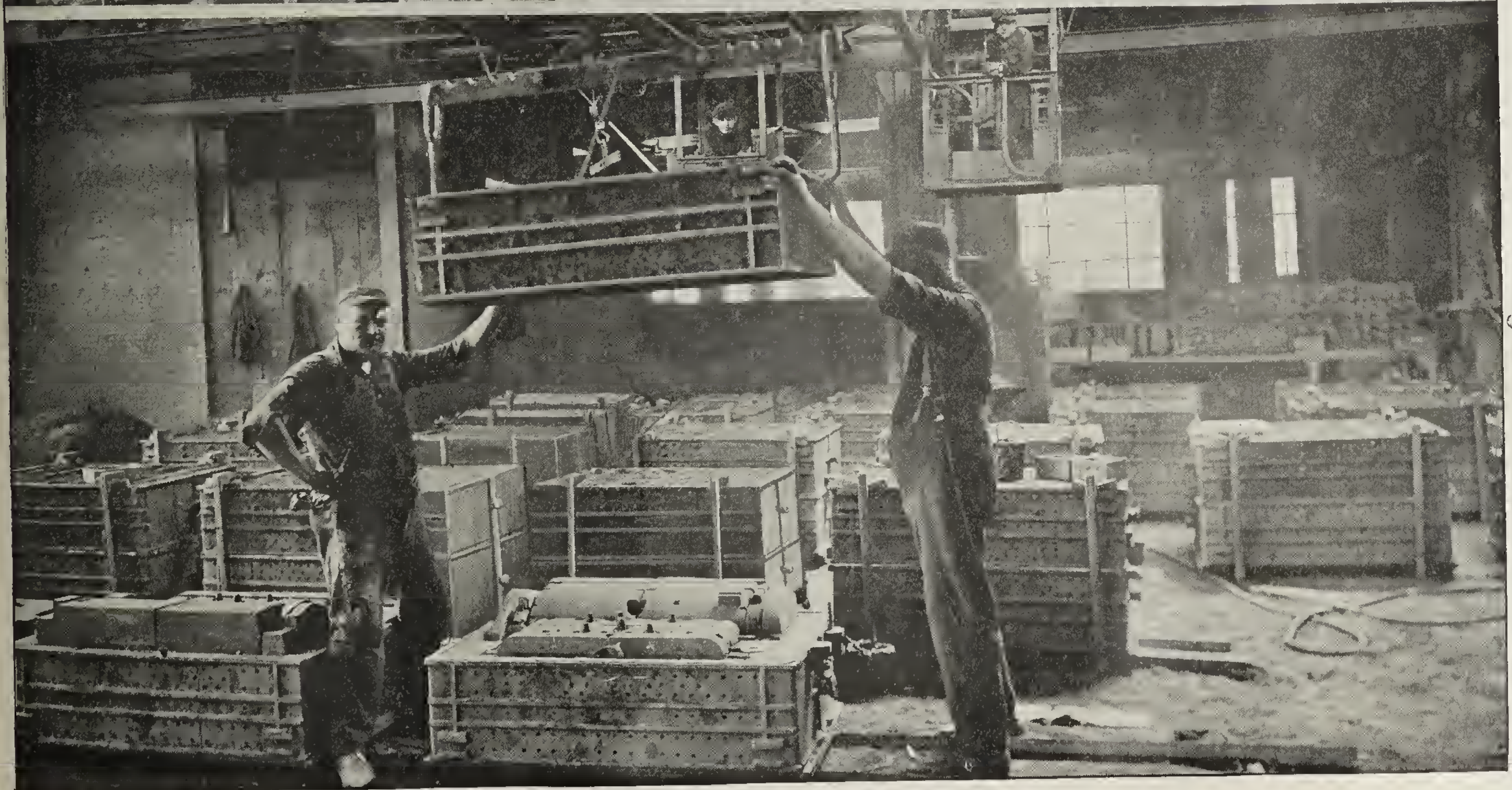


FIG. 5—MOLDING FLOOR IN THE WEST BAY SHOWING CRANE FACILITIES AND TRAMWAYS FOR CARRYING THE MOLTEN IRON—THE FOUNDRY IS WELL LIGHTED AND VENTILATED

FIG. 6—THE FOUNDRY IS DIVIDED INTO A NUMBER OF COMPLETE, INDIVIDUAL MOLDING FLOORS—THIS ILLUSTRATION SHOWS THE EQUIPMENT ON ONE OF THESE FLOORS

FIG. 7—CLOSING THE MOLD FOR A LARGE 6-CYLINDER ENGINE IN ANOTHER PORTION OF THE WEST BAY

which are used for handling empty flasks, placing the copes on the drags and similar work. The cranes are of 2-ton capacity. They were built by the Johnson & Jennings Co., Cleveland, and were furnished by the Euclid Crane & Hoist Co., Euclid, O. The west and south bays are served by six and four of these cranes, respectively.

Molds poured during the day are broken up and cleaned by laborers on the night shift. About 225 men are employed on this shift. A large percentage of the sand is reclaimed by passing it through ⅜-inch mesh screens, mixing sufficient new sand with the old to provide the proper cohesion. Enough flasks are supplied to each floor to meet the requirements of the day's output. The general arrangement of a single floor showing the empty flasks and the two molding machines is illustrated in Fig. 6. A double line of completed molds may be seen in the foreground. Fig. 7 shows one of the larger engine molds being closed.

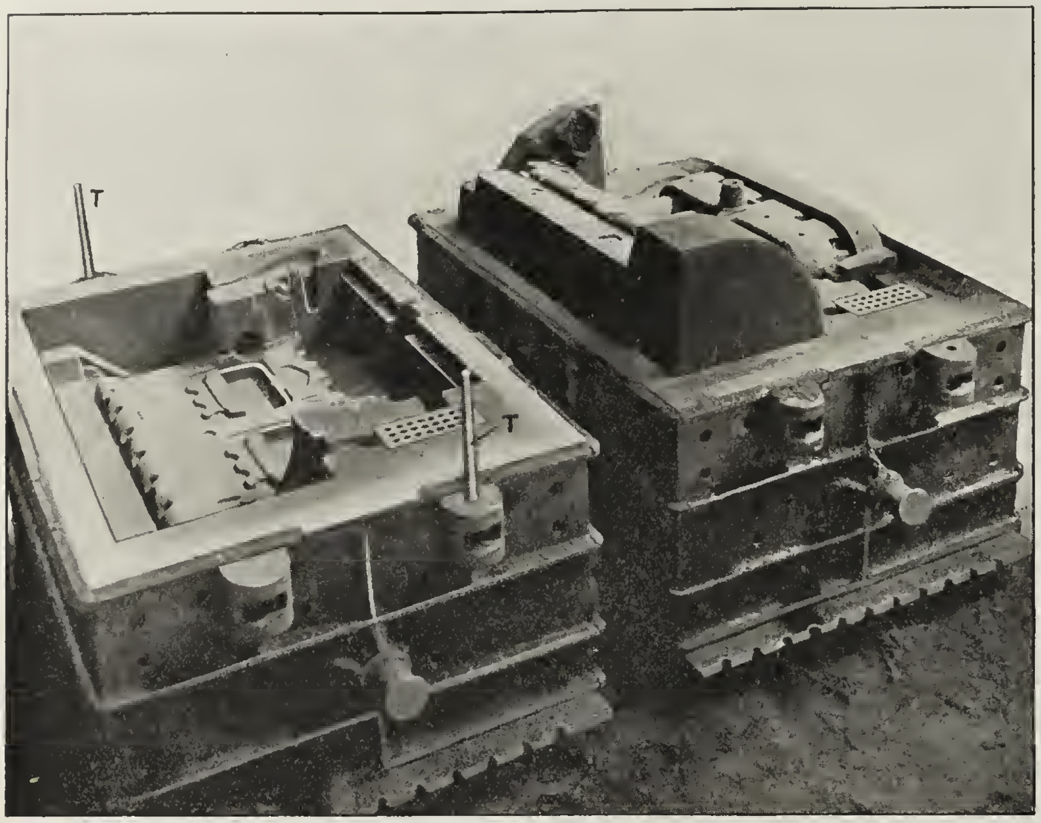


FIG. 8—THE PINS *TT* SLIP THROUGH HOLES IN THE JIG SERVING TO LOCATE THE CORES ACCURATELY IN THE MOLD—THE MOLD TO THE RIGHT IS READY TO BE CLOSED

One of the most prominent features in the development of foundry practice to produce large quantities of automobile castings is the tendency to use jigs for assembling the various cores and molds. Although jigs have been used extensively for some time in corerooms for assembling cores and finishing them to the proper shape, this means of saving time and of assuring accuracy has not been extended generally to the molding floor until comparatively recently. Several ingenious devices have been adapted by the Ferro foundry to secure precision in the placing of the cores in the mold, to effect the desired distribution of the metal in the casting and to accelerate production.

A typical example of the use of assembling devices on the molding floor is illustrated by the preparation of the molds for a 4-cylinder truck engine. The cores are assembled in a wooden jig hinged to a platform. The crank-case core is first slid into the base of the frame or jig, being located accurately by several blocks against which it is pushed. After the crank-case core has been set in its place in the jig, two special fixtures which serve to locate the spring-housing core are screwed into position, as shown in Fig. 4. The two steel arbors around which the crank-case core is rammed, the upper surfaces being flush with the two outer barrel core prints, are provided with threads to receive the two special fixtures. The position of these arbors in the core is shown in the core-assembly drawing, Fig. 4, and by the arrows and dotted lines in Figs. 2, 3 and 4.

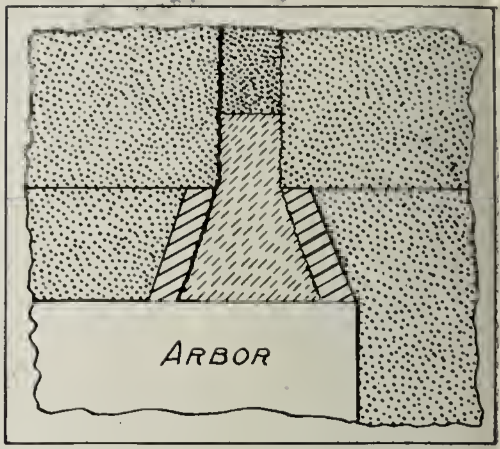


FIG. 9—HOW LEADING FASTENS THE SPRING-HOUSING CORE TO THE CRANK-CASE CORE

The arbors also provide a means of fastening the valve spring-housing core to the crank-case core. The

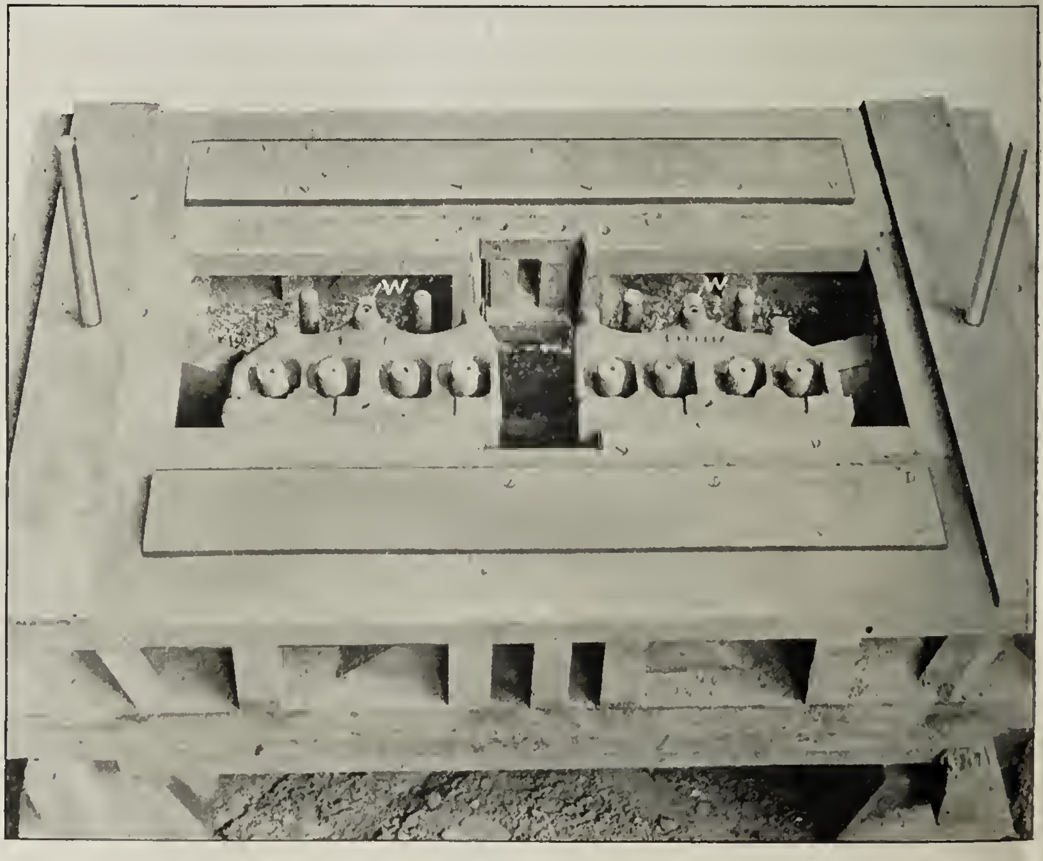


FIG. 10—JIG FOR HOLDING CORES WHILE THEY ARE BEING LEADED TO GREEN-SAND MOLD—THE LEAD IS HELD BY LOOPS OF WIRE AT *WW*

manner in which this is accomplished is indicated by the diagram shown in Fig. 9. Molten lead, which is poured into small holes, projects through the spring-housing core, piercing the under surface immediately above the hole in the part of the arbor which is flush with the surface of the crankcase core at this point. Fig. 2 shows how the assembler performs this operation. The lead flows into the conical-shaped opening in the arbor and into the ports of the sand and, on hardening, firmly binds the two cores together. Talc paste is used to plug the two holes after leading. The two special fixtures for locating the spring-housing core are removed and the barrel or cylinder cores are pasted in their proper positions.

The two end cores are made around steel arbors similar to the one shown at *A* in Fig. 13. The cylinder-head core is set in place and bolted securely to the barrel and crank-case cores by means of two long bolts which pass through the arbors in the outer barrel cores and screw into the crank-case core arbors. Fig. 3 illustrates this last step in the assembly and shows how all the cores are brought to correct relation with one another by tightening the two bolts.

Setting the Cores in the Drag

In this condition the completely assembled cores are ready to be placed into the drag. Tipping the jig forward on the hinges provided for this purpose brings the cores into a horizontal position ready to receive a steel skeleton jig which is used to carry the cores to the drag. Holes in this jig slipping over the pins shown at *P P* in Figs. 1, 2 and 3 serve to align the cores in the jig. After tightening the thumb screws, which screw into the arbors and which are indicated at *S S* in Fig. 1, the cores are carried to the drag, being guided into the proper position by the long tapering pins, *T T*, Fig. 8. This illustration shows a drag ready to receive a completely assembled core and one with all the cores in place waiting for the cope to be dropped into place to close the flask. The fly-wheel housing and the gear cores are set in the mold by hand after the jig-assembled core has been set.

This method of core assembly possesses several advantages. By locating all the cores of the several components of the engine casting with reference to one of the cores, the correct alignment of these parts is assured; the crank and the cam bearings will be accurately located and the desired thickness of metal will be secured when the metal is poured into the mold. The rigidity obtained by bolting the several cores together minimizes the danger of any of the cores slipping under the stress or pressure of the molten metal as it flows into the mold. Chaplets are made unnecessary by this scheme. Not only does this method enhance the precision of the work, but it also makes possible the use of unskilled labor to assemble a large number of cores in a minimum of time.

Division of Labor

Copes for the molds for this 4-cylinder engine job are made by three men who operate a roll-over, jar-ram molding machine made by the Osborn Mfg. Co., Cleveland. The drags are molded on a similar machine made by the International Molding Machine Co., Chicago. This work is handled by two men. Three men are kept busy placing the cores in the molds. One man working on the jig assembles sufficient cores to keep up with the rest of the crew. These nine men, together with two laborers who carry the assembled cores, etc., are able to close 50 molds in one day.

Another unique application of the use of lead is a scheme to anchor cores to green sand molds, as illustrated in Figs. 10, 11 and 12. On this job a small 8-cylinder motor, the spring-housing core is leaded to small straps placed in the flask before it is rammed. The arrangement of these straps or bridges is indicated by the sketch shown in Fig. 12. While the flask is being rammed, small rods, about ¼ inch in diameter, are set into the conical openings in the straps and allowed to project through the sand to provide a gate for the molten lead. The spring-housing cores are held in a jig, Fig. 10, on which the cope is placed. When the molten lead is poured through the holes in the cope it flows under small loops of wire which are rammed in the cores, as indicated at *W* in Fig. 10. After the lead has solidified,

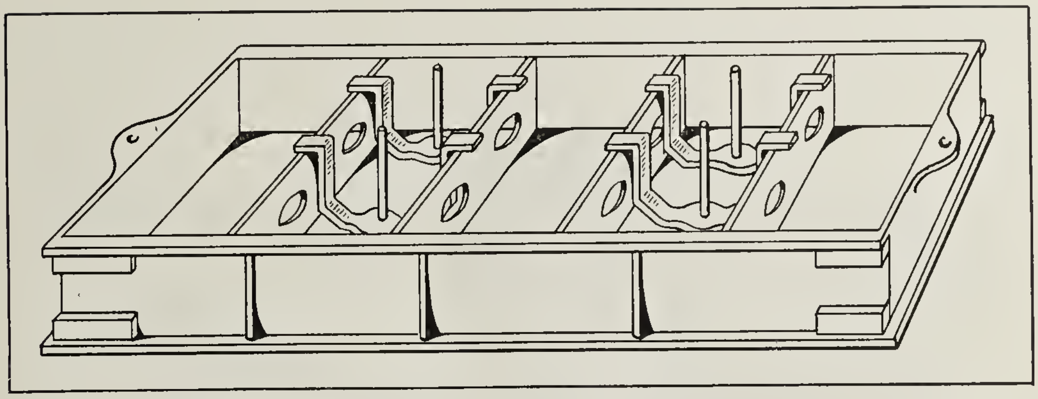


FIG. 12—DETAIL OF COPE SHOWING HOW BRIDGES ARE PLACED TO SUPPORT THE CORES

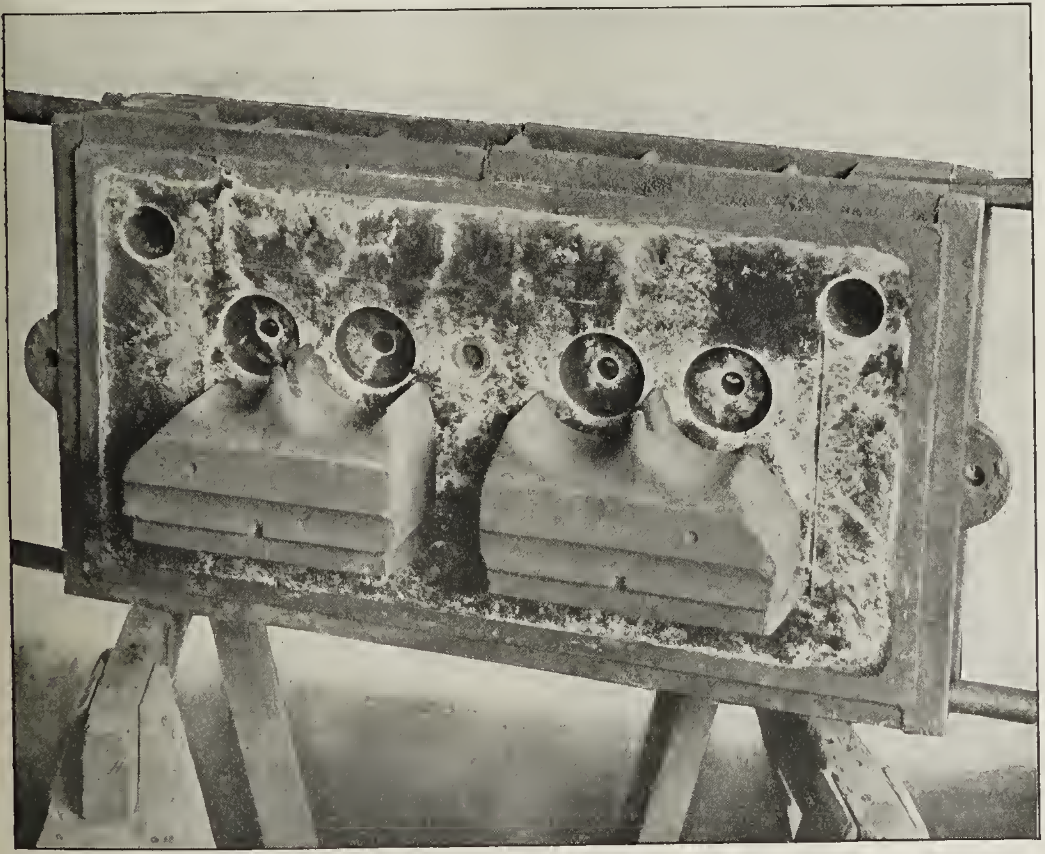


FIG. 11—AFTER LEADING THE CORES ARE HELD SECURELY TO THE COPE

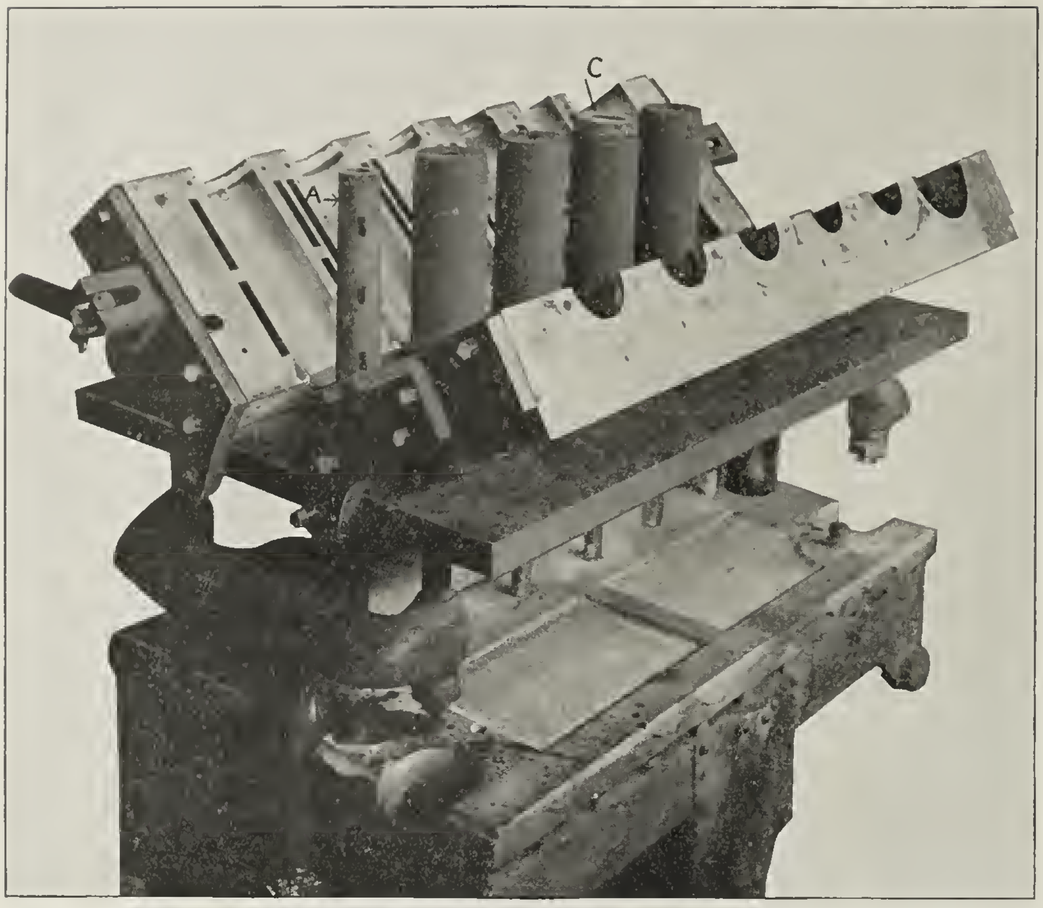


FIG. 13—MOLDING MACHINE FOR MAKING GREEN-SAND BARREL CORES

the cope is lifted from the jig, the core being accurately located and securely fastened, as shown in Fig. 11.

Green Sand Cores

Cylinder-barrel cores for several of the jobs which are assembled by bolting, as outlined in previous paragraphs, are made on a special jolt machine built by the Osborn Mfg. Co., Cleveland. Green sand cores are used. This machine, which is shown in Fig. 13 in position for removing the cores, makes six cores at one time, either with or without the arbors. The slots in the arbor shown at *A* in this illustration provide an exit for the gases. The arbors are coated with a paste before ramming to make the sand stick and are tapered to facilitate removal after the cores have been used. By changing the sleeves which form the outer surface of the cores, a number of different sizes and shapes may be produced on the one machine. The cap that is placed on the end of the core fitting into the cylinder-head core is shown at *C,* in Fig. 13.

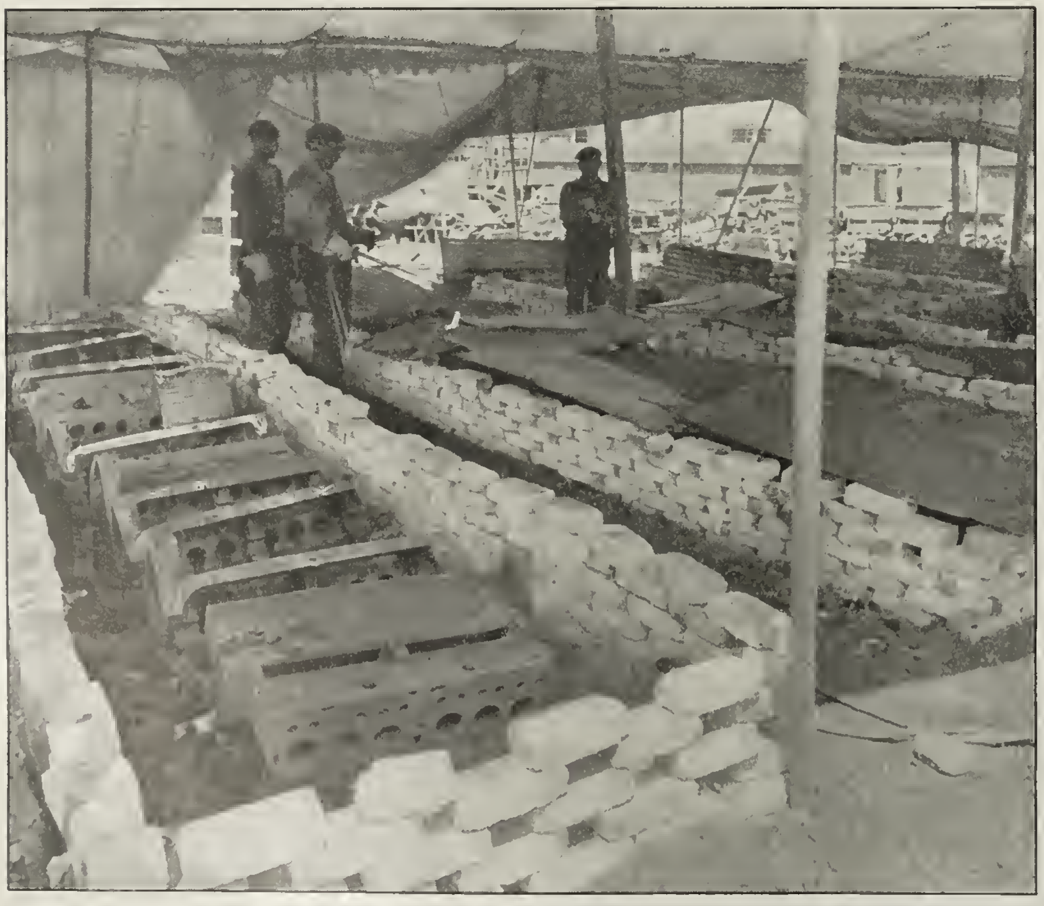


FIG. 14—DURING THE SUMMER MONTHS THE CASTINGS ARE WELDED IN A LARGE TENT—CRUDE CHARCOAL OVENS REPLACE THE GAS OVENS TO BE FOUND REGULAR DEPARTMENT

Pig iron for the cupolas is unloaded from the freight cars by a locomotive crane furnished by the Browning Co., Cleveland. This crane is equipped with a magnet made by the Electric Controller & Mfg. Co., Cleveland. The coke is dropped into a coke-storage pit from hopper cars. Both the pig iron and the coke are transported to the charging floor in small cars drawn by an electric truck. Two cupolas located in the approximate center of the foundry are used to prepare the iron for pouring. The average daily melt is from 100 to 130 tons.

Special Features of Cupolas

The cupolas, which were built by the J. W. Paxson Co., Philadelphia, are provided with six upper or secondary tuyeres at the top of the bosh. These tuyeres are equipped with independent lever gates. While the lower tuyeres give a nearly continuous opening providing a low air velocity, the six smaller openings of the upper tuyeres introduce air at a higher velocity and, it is said, serve to furnish a draft for the escaping gases. It is claimed that this assists combustion and confines the heat to the bosh where the melting action takes place. The introduction of a large volume of air into the melting zone, at a low pressure and velocity, tends to supply the oxygen evenly, thus producing rapid and even melting. Air is supplied to the cupolas by two blowers built by the Connersville Blower Co., Connersville, Ind., driven by 50-horsepower, alternating-current motors manufactured by the Burke Electric Co., Erie, Pa.

The metal is carried from the cupolas to the molds on tramways or monorails. Pouring usually is started about two hours after the molding crews start in the morning, continuing throughout the day. After they are poured, the molds are allowed to remain on the floor until night, when they are shaken out by laborers.

The entire basement of the foundry building is devoted to chipping and cleaning. Various castings are brought from the foundry to this deartment on an elevator, from which ey are transferred to the sand-blast ooms. Equipment furnished by the . W. Sly Mfg. Co., Cleveland, and e Pangborn Corp., Hagerstown, d., is used in the two sanding ooms. After being cleaned by sand lasting, the larger irregularities in e surfaces of the castings are removed by seven grinders of the swing-rm type.

At this stage, first inspection takes lace. This division of the work is andled by five men who inspect the astings on low steel tables. The astings are chipped by a crew of 50 en using air hammers made by the ittsburg Pneumatic Co., Canton, O. bout 35 of these men devote their ttentions to cylinder castings; the emainder chip miscellaneous castings. water-test of the cylinders follows e chipping operation. In this ranch of inspection, 15 men apply ater to the castings at 100-pound ressure. If leaks are indicated by his test, the castings are sent to the welding department, or, if the fault is too severe, the cylinders are scrapped.

Small cylinders, cylinder heads and similar castings are tumbled in a battery of twenty-six 30 x 36-inch barrels. Four large 48 x 80-inch barrels made by the Sly company are used for the heavier pieces. The final grinding of the castings for finishing is accomplished on a battery of seven pedestal-grinders. All grinders and tumbling barrels are supplied with dust exhausters.

Outdoor Welding Department

Small cracks and surface defects in the castings are eliminated by the application of the oxy-acetylene flame. Three gas-fired furnaces having an individual capacity for six large cylinder castings or 18 small ones heat the castings preparatory for welding. Gas for this process is generated in the plant by equipment furnished by the Oxweld Acetylene Co., Chicago. In the summer months, when the warm weather coupled with the heat from the furnaces and the welding flames almost precludes the use of the equipment in the cleaning department, a large tent is erected near the cleaning room and the castings are heated by charcoal in brick ovens and welded by means of portable equipment. The general arrangement of this humanitarian expedient is illustrated in Fig. 14, which shows how the castings are placed in the furnaces and packed with charcoal. The portable welding apparatus was manufactured by the Prest-O-Lite Co., Indianapolis.

The final inspection of the day's output of 1100 or 1200 cylinder castings takes place on the main floor of the building near the shipping platform. Tests to ferret out any defects such as those resulting from cores being set off-center are conducted in this department. Various jigs and gages are fitted to the castings before they are finally released to the shipping department.

How Malleable Iron Has Improved

By Enrique Touceda

I HAVE been asked to prepare an outline containing data that might assist in indicating the progress that as been made during the past few ears in the improvement of malleale iron. It is believed this can best e done by tabulating the results of nany hundreds of tests, starting from he time they began to be systematcally conducted, presenting the averges in suitable form.

While prior to November, 1915, tenile test bars were sent me by the vaious concerns for whom I am conulting engineer, with frequency, but t odd intervals, it was not until the late referred to that it was decided o send on test bars daily which vould fairly represent the product of ach day's run.

The record that will first be preented consists of the average ultinate strength and elongation of all ars received during the last two nonths of 1915; of all bars received luring the whole of 1916; and of all ars received during the first five nonths of 1917.

To the end that you may obtain a learer idea of what these tests indiate than if you were furnished simly with the average ultimate strength nd elongation of the total number of bars received during these various periods, the results have been classified into various grades, as shown in Table II. About 18 separate companies furnished these bars. Therefore, this data is derived from tests of bars sent me by a very significant number of concerns.

Looking over my records prior to the year 1914, in which there is abundant data, it was found that the average ultimate strength and elongation would approximate about 38,000 pounds ultimate and 3.50 per cent elongation respectively though there are occasional instances of a 46,000 and 48,000 pounds only with a 6 or 7 per cent elongation. On looking over these old records it is found that the test bars then submitted were of many different dimensions varying anywhere from ½ to 1 inch in diameter, while some were square and others rectangular in section. For this reason it is hardly possible to gather from this data any conclusions which can be compared accurately with the material that has passed through my hands since the beginning of 1914.

It will be noted in Table II that the proportion of the 1915 bars that failed to test up to 40,000 pounds was 5.80 per cent. In 1916 this ratio dropped to 2.57 per cent, and in 1917 to 1.68 per cent. Only 2.40 per cent of the bars exceeded 52,000 pounds per square inch ultimate in 1914, as against 16.76 in 1916, and 18.49 per cent in 1917. In 1914, 72.35 per cent of the bars exceeded 44,000 pounds per square inch ultimate, while in 1915, 86.42 per cent, and in 1917, 88.85 per cent exceeded that figure.

When the great difficulty that has been encountered by the manufacturer within the past six months in securing suitable coal and iron for his pur-

Table I

Data Demonstrating Uniformity

JUNE RECORD, FOUNDRY A

Ultimate strength, lbs. per sq. in.	Elongation in per cent
46,032	8.59
50,631	8.59
46,700	8.59
50,213	8.59
46,917	7.03
48,344	7.03
47,324	6.25
54,028	9.38
46,540	8.59
48,761	7.03
51,012	9.38
49,255	7.81
47,706	7.81
52,422	7.81
50,733	9.38
47,444	9.38

JUNE RECORD, FOUNDRY B

Ultimate strength, lbs. per sq. in.	Elongation in per cent
50,338	12.50
51,734	16.41
52,343	18.75
52,011	15.63
50,937	13.28
50,700	10.94
51,938	14.84
49,899	14.84
51,476	14.84
52,780	11.72
50,400	9.38

A paper presented at the Boston meeting of he American Foundrymen's association. The uthor, Enrique Touceda, is consulting engieer, Albany, N. Y.

pose is considered, the continued improvement in 1917 is certainly quite remarkable, as the handicap has been very large.

Another important fact that can be gathered from the data in Table II is that malleable iron of good quality is very different from other ferrous products in one particular, in that its elongation increases with its ultimate strength. Prior to the discovery of this fact it had invariably been assumed by all writers on this subject that the reverse was true.

Table II

Summary of Tests of Malleable Iron

	Per cent of bars under 40,000 lbs. ultimate.	Per cent of bars between 40,000 and 42,000 lbs. ultimate.	Per cent of bars between 42,000 and 44,000 lbs. ultimate.	Per cent of bars between 44,000 and 46,000 lbs. ultimate.	Per cent of bars between 46,000 and 48,000 lbs. ultimate.	Per cent of bars between 48,000 and 50,000 lbs. ultimate.	Per cent of bars between 50,000 and 52,000 lbs. ultimate.	Per cent of bars over 52,000 lbs. ult.
1915— Covering last two months:								
Ave. ult. lbs. per sq. in.	5.80	9.47	12.38	21.44	21.15	16.22	11.05	2.49
Ave. elong. per cent in 2 in.	4.91	6.55	7.38	8.87	9.47	10.17	11.27	13.38
1916— Entire year:								
Ave. ult. lbs. per sq. in.	2.57	3.65	7.36	13.64	18.26	21.57	16.61	16.76
Ave. elong. per cent in 2 in.	5.78	6.88	7.48	8.33	9.14	10.28	11.61	12.72
1917— Covering first five months:								
Ave. ult. lbs. per sq. in.	1.68	2.75	6.72	12.83	20.53	20.22	16.78	18.49
Ave. elong. per cent in 2 in.	5.78	7.37	8.20	8.72	10.11	11.51	12.97	14.94

All bars ⅝-inch diameter, and similar in all particulars to the tensile test bar recommended by the A. S. T. M. in its specifications for malleable iron.

While it is believed the foregoing data unmistakably demonstrate the fact that a healthy improvement in the quality of malleable iron has taken place within the past few years, they do not tell the whole story. One of the most serious shortcomings in malleable iron in the past has been its lack of uniformity. I consider the improvement that has been accomplished in this direction within the past few years to have much more far-reaching effect on the user of this metal, and to be of greater importance to him than the ability of the founder to obtain high strength and ductility. A high ultimate strength is not always specified owing to the belief on the part of some that when the ultimate strength is in the neighborhood of 42,000 pounds per square inch the machine tools can be speeded up to a considerably higher rate than is possible when working with metal having ultimate strengths around 48,000 to 50,000 pounds. This is a matter we will not discuss at the present time. If the individual record of many of the concerns, the results of whose physical tests are included in the data in Table II were examined, it would be found that they have made a practically uniform run day in and day out for a period covering many months. Those whose showing is more erratic are improving in this particular from month to month.

The figures in Table I were taken from records covering iron made during June. These data demonstrate the uniformity in the quality of the material from many consecutive heats, illustrating the fact that the manufacturer of malleable iron who is well posted in malleable practice has full control of his product. The day of "hit or miss" has passed.

Table III, however, records a run of 17 consecutive heats made during February, of this year. The average ultimate strength of the 17 bars is 52,784 pounds and the average elongation is 17.88 per cent. in spite of the fact that two of the bars contained a slight shrink which made them fail prematurely. In this set there are four bars with over 21 per cent elongation; one with 24.22 per cent, and one with 27.34 per cent. We have tested many bars within the past two years having an elongation as high as 24.00 per cent, but it is believed that 27.34 per cent is the record elongation of any malleable iron test bar ⅝-inch diameter yet produced. I might add that the reduction of area of this bar was 22.71 per cent. The data in this table are furnished because they clearly demonstrate what is possible to achieve along the line of quality and uniformity, the goal toward which we ar aiming.

As I have made mention of no ter sile tests aside from those made o the standard tensile test bar recor mended by the American Society fc Testing Materials, it may be of ir terest to make record of the result of tests on bars with different-size sections. Some four months ago si sets of bars cast from the same hea and of these sizes were sent me:

Set No. 1, 12 bars, ⅝-inch diameter.
Set No. 2, 6 bars, ¾-inch diameter.
Set No. 3, 6 bars, ⅞-inch diameter.
Set No. 4, 6 bars, 1 -inch diameter.
Set No. 5, 6 bars, 1⅛-inch diameter.
Set No. 6, 6 bars, 1¼-inch diameter.

The *average* results are as follows

Set marked	Ultimate strength lbs. per sq. in.	Elongatic in per cent
No. 1— ⅝-inch	52,141	15.62
No. 2— ¾-inch	48,062	10.54
No. 3— ⅞-inch	47,107	9.37
No. 4—1 -inch	47,317	11.56
No. 5—1⅛-inch	47,148	9.69
No. 6—1¼-inch	46,592	9.69

The foregoing table should serv as a complete answer to those wh maintain that when malleable iron ex ceeds ⅝-inch it cannot be mad strong or ductile. Our experience ir dicates that provided a casting i sound, high quality malleable iron ca be produced today just as easily i sections around 1¼ inches thick as i the case of ⅝-inch sections. With ir creased thickness there naturall comes increased difficulty in removin all the shrinks, but we have withi the past few years made great stride in the direction of securing perfec soundness in thick and intricately de signed castings.

In short, great progress has bee made in improving the physical properties of malleable iron solely anc only because of a determination or the part of the manufacturers to systematically improve each step in the process. It is believed that the figures placed before you indicate tha they have more than achieved a fair measure of success.

Table III

Tests Reveal Average High Quality

February Foundry Record

Ultimate strength, lbs. per sq. in.	Elongation in per cent
55,032	21.09
53.908	21.09
54,706	21.09
52,010	17.19
50,321	10.94*
54,867	17.19
54,283	13.28
53,537	21.09
55,804	27.34
51,380	11.72
51,978	24.22
52,506	17.97
52,477	17.19
50,097	14.06
49,910	12.50*
52,204	17.97
52,311	17.97

*Test bar broke in fillet.

Steel Castings For Ordnance Construction

The Second Installment of an Article Describing the Methods Employed in the Steel Foundry of the United States Arsenal at Watertown

By Major C M Wesson

I PREVIOUSLY referred to the earlier difficulties in procuring steel castings some 17 years ago. Today the situation as regards the larger castings of the lower grades is satisfactory, but as regards the small higher grade castings, it is still far below what it should be. The Rock Island arsenal and the large private ordnance manufacturers have been having great difficulties in securing satisfactory small castings. I learned recently that a number of large howitzer carriages, which are being manufactured by a large private corporation, have been greatly delayed in completion, because two separate sub-contracts, which it placed for the small castings involved, had been cancelled on account of failure to deliver them.

In connection with this subject, I quote from an official letter of recent date as follows:

"A reply to preceding endorsement has been delayed with a view to determining what success we would have in obtaining steel castings on existing contracts placed with steel casting manufacturers. * * * The results, except for cast steel No. 1, are very discouraging. Practically all of them make "steel castings," generally without regard to physical qualities. Cast steel No. 3 and No. 2 are almost beyond their ability. Many of them with whom the subject has been taken up knew nothing about physical qualities. We had expected to obtain satisfactory results from the * * * but they are having much trouble with a large order for steel castings No. 3. It is apparently due to their inability to obtain coke with a low sulphur content." As regards this question of sulphur, I personally believe that if the sulphur difficulties are not sufficient to prevent the production of the No. 2 grade, there should be no reason why the No. 3 grade could not be made.

Satisfactory small steel castings of both the No. 2 and No. 3 grades can be made, and by any of you who possess ordinary foundry equipment, if you will take the precautions to procure suitable material, and exercise the proper care as to details. These latter extend not only to the production of the metal itself, but include the essential items of mold treatment, molding sand, gates, risers, etc. The best metal that can be produced will result in porous or cracked castings, if the mold which receives it does not measure up to certain requirements. This problem of the mold you are meeting every day in castings demanded for the motor-car industry, and others where intricacy of pattern equals, or is greater than that encountered in ordnance work.

In the remainder of this paper are outlined the basic features on which the practice at the government arsenal at Watertown rests. No claim is made to originality. The practice outlined is believed to represent good methods. Unquestionably, there is large room for improvement. The equipment of the foundry at Watertown arsenal may be subdivided under the following headings: (1) Molding, (2) drying, (3) melting, (4) annealing, and (5) cleaning.

The molding equipment consists of one jar squeezer for brass work, 22 x 26-inch table, 36 inches between supports; one 6 x 4-foot jolt machine; one

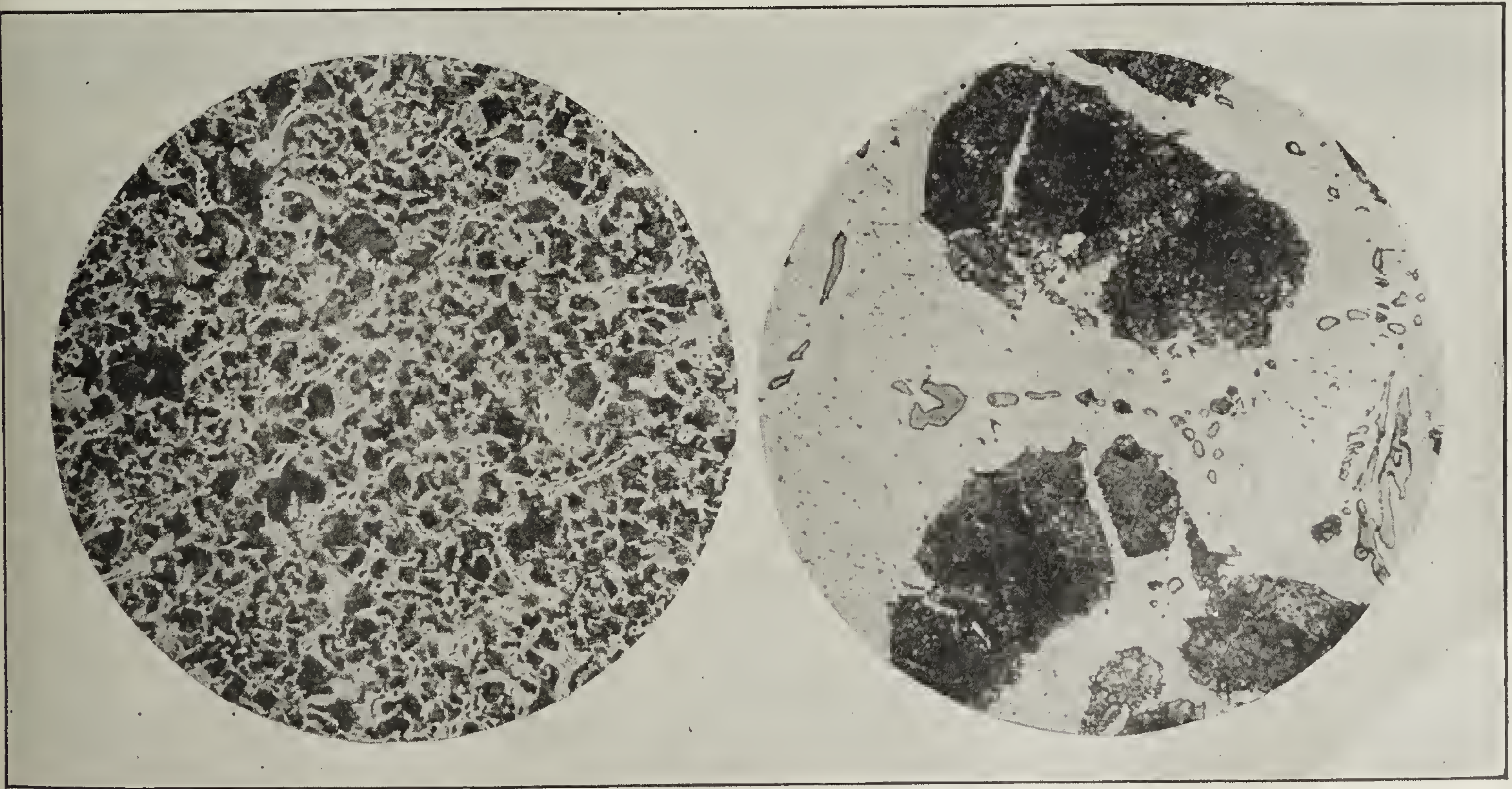


FIG. 1—MICROSTRUCTURE OF NO. 3 CAST STEEL DEFICIENT IN DUCTILITY

At the left, 50 diameters; at the right, 500 diameters. Carbon, 0.42 per cent; manganese, 0.72 per cent. Yield point, 52,500 pounds per square inch; tensile strength, 85,500 pounds per square inch; elongation, 9.5 per cent; contraction, 9.5 per cent

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Second and final installment of a paper read at the Boston meeting of the American Foundrymen's association, Sept. 24-28. The author, Major C. M. Wesson, is officer in charge of manufacture Watertown Arsenal, Watertown, Mass.

3 x 3-foot jolt machine; and one 18 x 24-inch jolt machine.

These machines are used for jolting dry or green sand steel work, small and medium in weight, also the small jolt is used for jolting snap-flask work, often with two flasks on one board. Heavy air rammers and light bench air rammers are largely used by the molders and are popular.

The drying equipment consists of one mold oven, 24 x 19 x 9 feet high; one mold oven, 22 x 15 x 10 feet high; one core and snap flask mold oven, 20 x 9½ x 10 feet high and one core oven, 18 x 6 x 10 feet high. The latter is served by two narrow gage cars, the oven opening at both ends and the cars entering one end from the core room and discharging from the opposite end into the foundry.

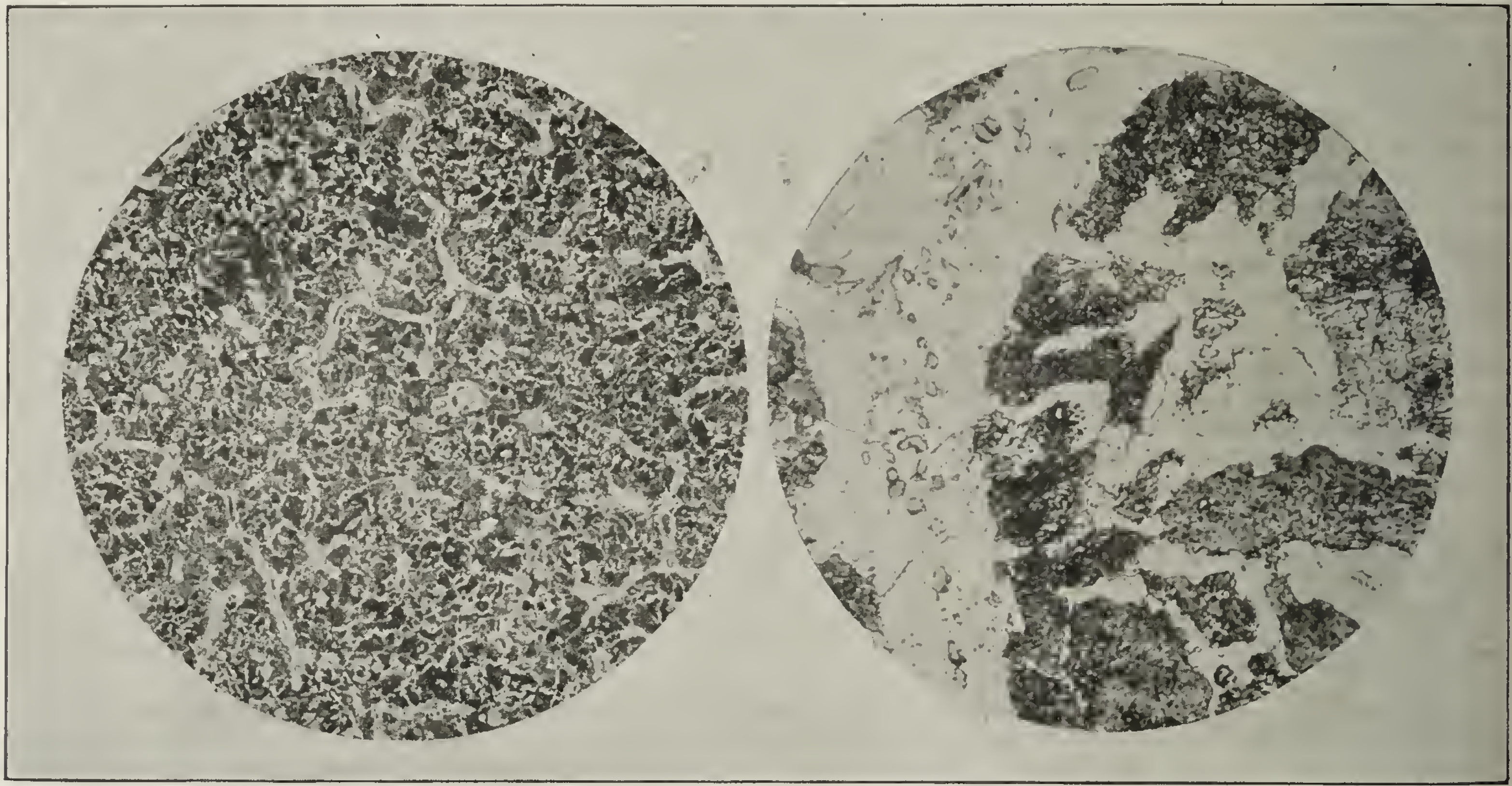


FIG. 2—MICROSTRUCTURE OF ANOTHER SPECIMEN DEFICIENT IN DUCTILITY

At the left, 50 diameters; at the right, 500 diameters. Carbon, 0.43 per cent; manganese, 0.72 per cent. Yield point, 51,500 pounds per square inch; tensile strength, 86,500 pounds per square inch; elongation, 7.5 per cent; contraction, 13.3 per cent

The melting equipment consists of one 15-ton tilting open-hearth furnace, oil-fired. This furnace can easily melt 15 heats per week of acid steel, using low-phosphorus stocks and steel scrap. It is served by thirty 3000-pound charging buggies on narrow gage tracks. All stock is elevated with a 3-ton electric hoist from flat cars. The charging is done by hand, assisted by two 1000-pound air hoists.

The converter equipment consists of a 2½-ton side-blow Tropenas converter with Roots blower, motor-driven, the blower equipment being in duplicate and one 42-inch cupola with charging platform 15 feet above the level of the foundry floor.

The charging platform is served by an elevator of about 10 tons capacity.

The equipment for melting alloy additions for the converter metal consists of drip-pan, oil-fired furances, served with chain hoists and overhead telpher. The ladle equipment consists of two 20-ton open-hearth ladles, bottom pour, and the usual number of top-pour worm-gear foundry ladles, from five tons capacity down; also one 2-ton bottom pour ladle for handling iron and steel from the converter. The ladles are heated by top fired combustion chamber ladle heaters.

In addition to the foregoing there are five coke-fired individual pot brass furnaces, taking pots up to No. 300.

The melting and molding bay is approximately 48 x 300 feet and is served by one 10-ton crane; one 20-ton crane with two 10-ton trolleys, and one 30-ton crane with two 15-ton hoists.

Annealing

The annealing equipment consists of two car bottom furnaces which are described in more detail later.

The chipping and cleaning shop is served by one 5-ton electric hoist; two 3-ton electric hoists; one 5-ton jib crane and additional chain hoists; three oxy-acetylene cutters and welders; one high-pressure two-nozzle air blast, the room being large enough for two 5-foot square buggies; one 8-foot sand mill; three cold saws; one two-wheel stationary grinder; and two cold saws for bronze work.

Castings to meet the various grades castings have large lightening cores specified above, or special grades of alloy steel castings when so specified, are produced in weights from a few ounces to 15,000 and 18,000 pounds each. Many of the castings are made from individual patterns, the orders for castings from each pattern usually not exceeding 100, many times not exceeding 10 to 20. Many of the sections of the smaller castings being very light and the design intricate, necessitates complicated core work and careful molding. Releasing to prevent hot checks and cracks is often necessary. Many of the heavier castings weighing from 2000 to 5000 pounds are bulky and of easy sections, some sections being 6 to 8 inches thick. Some of the heavier and thinner sections are as low as 1 inch in thickness, and hence difficult to produce. It will thus be seen that there is a great variety of castings being produced.

Nearly all of the work is made in dry sand, using various mixtures of silica sand, silica rock, heap sand, clay and molasses water. The mixtures are transferred to the molding floor in wooden boxes. These mixtures are worked out by the superintendent and the foreman according to the nature of the work, and are varied from time to time according to the available materials. A large percentage of ground silica rock has always been used by the arsenal foundry, and while its cost has been considerably greater than the cost of an equivalent amount of 98 per cent pure silica sand, the results have been so satisfactory that its use has been considered well justified. There has been an unusual lack of the most common foundry troubles, such as scabs, drops, washers, crushers, broken cores, etc., and the cost of cleaning and chipping off of burned sand adhering to the castings has been found to be quite low. The use of old heap sand in the mixture of stronger facings has been kept down to a minimum, and while its use might possibly be increased in some cases, any great increase would probably show a corresponding increase in expense of cleaning and losses due to defective castings.

Due to the fact that virtually all of the arsenal castings are subject to specifications to meet difficult service, and many of them are machined all over and practically all of them machined in part, it has been found difficult to satisfactorily produce much of such work in green sand. Occasionally, the percentage of work made in green sand can be increased.

There is no jar-squeeze work done. There is a small amount of straight jolt work done on the small jolt machines, using snap flasks; all such work being dried. There is a considerable amount of small and intermediate work from individual patterns made on straight jolt machines and these are butted off with hand air rammers. Probably not over 15 per cent of the man hours of the shop are applied on molding machine work.

Whenever possible, castings are gated and poured from the bottom and the usual foundry rules in this respect are followed as to the size of gates to give proper speed of pouring, etc.

The location of risers has been worked out in the superintendent's office, in conjunction with the foremen of the pattern shop and a riser boss. Correct risers have been provided by the pattern shop before the patterns are delivered to the foundry. This makes it possible to be assured that risers of the correct size will be properly located by the molders, even though a new molder may get a pattern with which he is not familiar. Previous practice which has been found satisfactory is thus transmitted automatically to the shop and adhered to. A common rule of keeping the height of riser approximately 1½ times its diameter has usually been found satisfactory. The percentage of riser necessary, naturally varies from almost nothing in some of the very light castings which do not require much feeding to 25 and 30 per cent in the heavier castings which may not solidify for two or three hours after pouring.

The majority of the converter blows are poured into steel castings. All of the small intricate-section snap flask castings are poured from the converter. Many of the medium and fairly heavy castings are likewise poured from the converter metal or from the open-hearth metal alternately, depending upon the desirability at the time. For example, on many of the smaller castings weighing as low as 400 or 500 pounds, which have thick sections and can easily be run with open-hearth metal, it has been found desirable to pour from the open hearth, because the metal is cheaper and slightly more uniform in chemical composition and meets the physical requirements more regularly.

On the contrary, many heavy castings that it would be desirable to pour from the open hearth (castings weighing up to 4000 pounds) may occasionally be poured from the converter metal as would be the case if the converter is running when the mold is ready and the open hearth is not ready or is on an ingot heat. The flasks are thus released and the production kept up although at a slight increase in the actual cost of the molten metal. On all the more important and heavier castings, at least two coupons are cast on the body of the casting. For the less important and lighter castings, either from the converter or the open hearth, two standard test coupons are cast from a single runner. These coupons are approximately 1½ inches at the bottom, tapered to 2 inches for a height of 5 inches and are 6 inches long. These test pieces are poured at about from the middle of the ladle. All test pieces and all castings are stamped cold with heat number and a serial casting number for identification during the manufacture and for record. All ingots, shell or otherwise, are tagged on top by the insertion, while in molten state, of a sheet steel strap stamped with heat number, serial number of ingot and code number of the grade of steel.

A 2½-ton drop-bottom Tropenas converter is used, lined with silica brick;

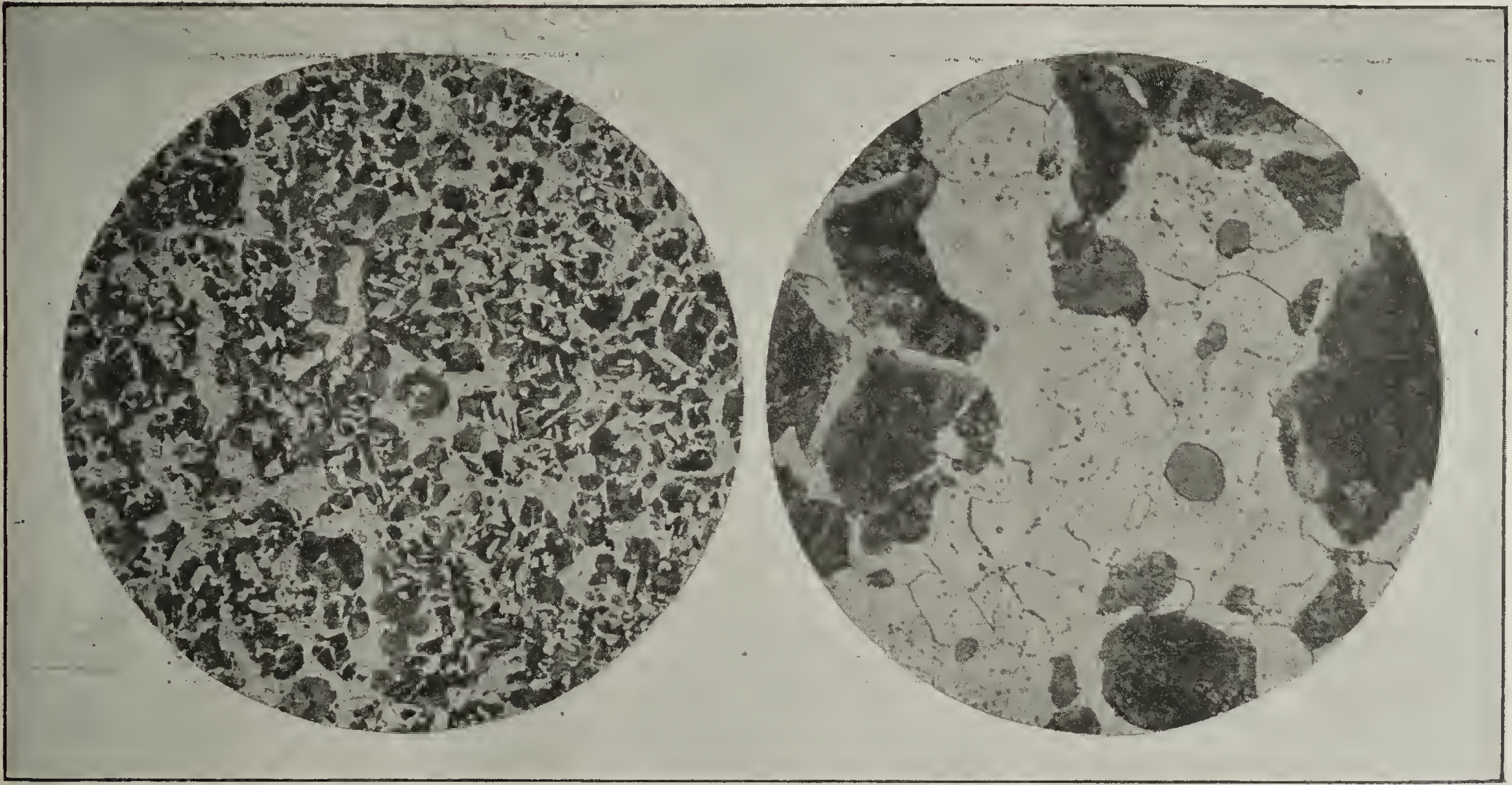
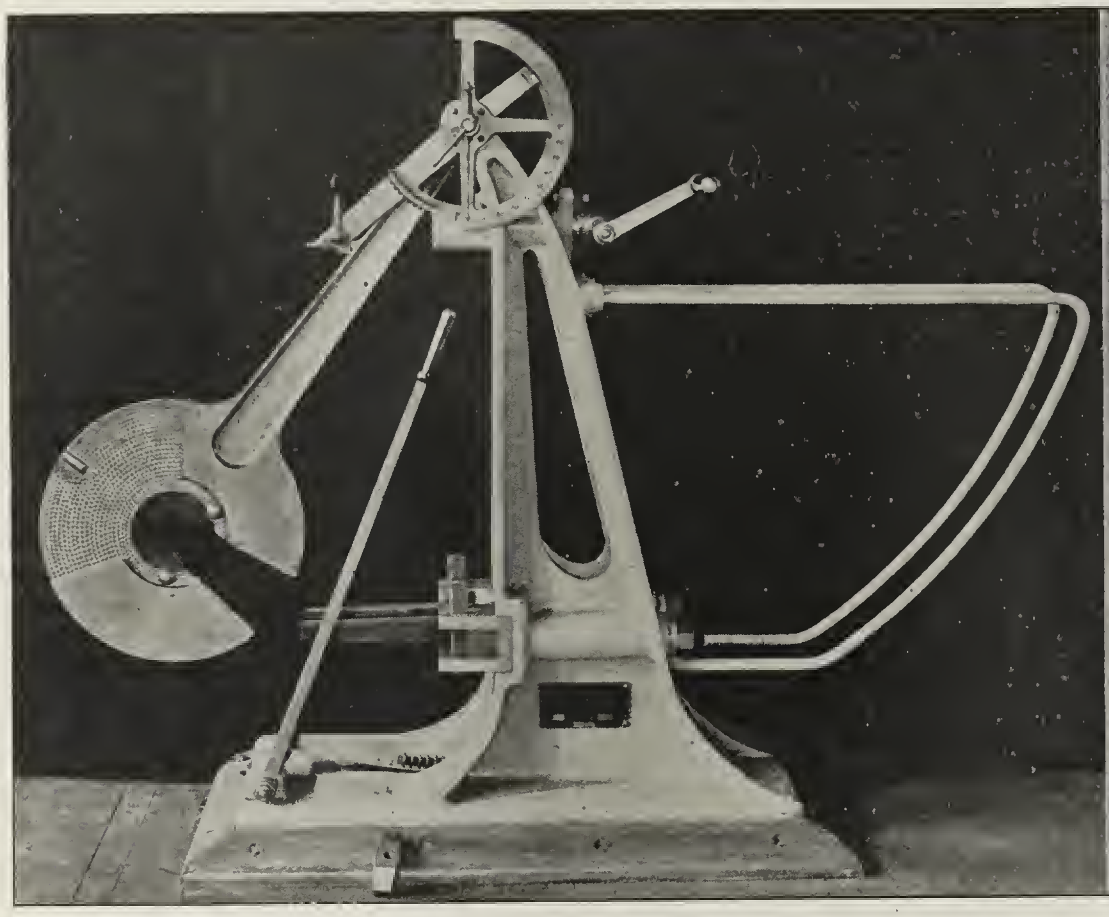


FIG. 3—MICROSTRUCTURE OF SATISFACTORY SPECIMEN

At the left, 50 diameters; at the right, 500 diameters. Carbon, 0.426 per cent; manganese, 0.52 per cent. Yield point, 45,400 pounds per square inch; tensile strength, 85,300 pounds per square inch; elongation, 18.0 per cent; contraction, 23.2 per cent next to the shell up to the tuyere blocks, the balance of the lining being a ganister mixture, composed of 18 parts of ganister, six parts of silica sand and four parts red clay, bone dry.

One-half of the rock is first put in the sand mill and, after partial grinding (15 minutes) one-half of the clay is added, all of the sand, the balance of the clay and rock in the order named. When sufficiently ground and mixed, it is wet down with thick molasses and water. The mixture is made only as needed as it is found that the results are not satisfactory after the mixture has stood too long. This mixture is used for patching, care being taken not to put the patch over adhering slag. In case of a shallow patch, which might otherwise spall off, a few large nails are inserted into the old lining to assist in holding the patch in place. Before putting on patch, the spot is daubed with thick molasses and also swabbed over with the same material when the patching is completed. Seven brick tuyeres are used. It is very important that the tuyere holes (not tuyere bricks) should always be used in the same horizontal plane when the converter is set plumb. The inside capacity of the vessel and the charge should be regulated in such a way that when blowing, the converter will be set at an angle of about 5 to 7 degrees, in no case more than 12 degrees.



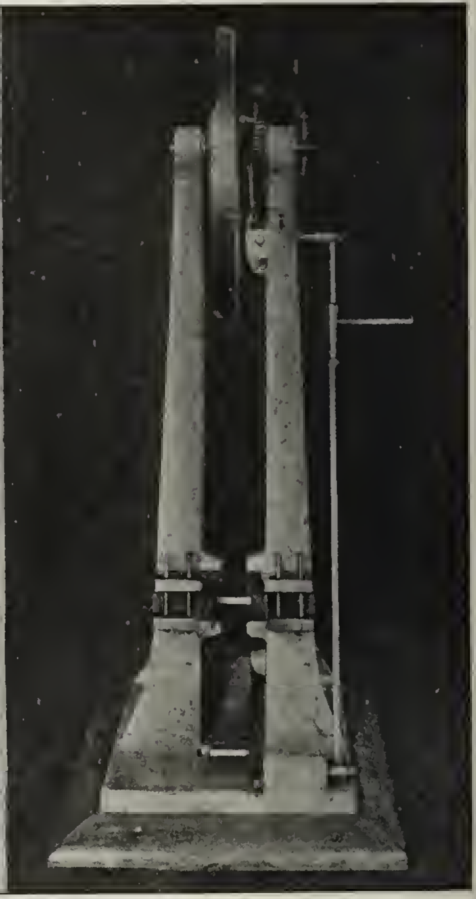


FIG. 4—SIDE VIEW OF CHARPY IMPACT MACHINE. FIG. 5—END VIEW OF CHARPY MACHINE WITH SPECIMEN IN PLACE FOR TESTING

Steel is blown on alternate days, running 8 to 12 blows per day, depending upon the tonnage on the floor to be poured. It is very essential to have ladle and converter thoroughly preheated before starting the first blow. The procedure in the case of the converter is as follows: At 4:30 a. m. the converter is filled with coke to well above the tuyeres and lighted up. From 5:30 to 6:00 the blast is put on, using about 1½-pound pressure. A grating is then put over the nose on the vessel and the converter burned upsidedown until 6:30 a. m. It is then turned up again and the blast put on for another half hour. This process is repeated with coke always well above the tuyere hole, until the vessel shell is approximately the temperature of boiling water. This will usually be between 8:00 and 8:15 a. m.

The pig iron used is high-silicon bessemer of the following specifications: Manganese not to exceed 1 per cent (generally runs about 0.15 per cent); sulphur and phosphorus not to exceed 0.035 per cent; silicon, 2.75 to 3.25 per cent, and copper not to exceed 0.75 per cent.

Crop ends are used, being purchased on same specifications as for the openhearth. From time to time, a car is picked out which contains a large percentage of pieces of the right size. Normally, gates and risers from castings are used, but if the open hearth is in operation it consumes all of this class of material, and the steel scrap portion of the converter charge is made up of low-sulphur and phosphorus crops, thus always keeping the sulphur well below the limit. The ferrosilicon used is the standard 50 per cent, ferromanganese 80 per cent, and ferrotitanium 15 to 18 per cent.

Cupola

The cupola is 42 inches in diameter with six 7 x 12-inch tuyeres set 16 inches above the sand bottom, the charging door being 110 inches above the tuyeres. Twenty-two hundred cubic feet of air per minute are used, bringing down 5700 pounds of iron about every half hour. The full charge is 5700 pounds, charged in 1425 pounds at a time. The cupola mixture will run from 40 to 45 per cent steel scrap with a coke ratio of about one to seven. By-product coke is used which is low in sulphur and ash, a typical analysis being about 0.53 per cent sulphur and 7.75 per cent ash. Ordinarily, about 20 pounds of lime rock are added to every 5700 pounds charge. This may vary, however, according to the amount of sand adhering to the pig and scrap. In case sulphur is running above the limit desired, 15 to 20 pounds of fine ferromanganese is used in the spout when tapping the cupola or lump ferro is charged in the cupola.

The cupola charge is adjusted so as to give approximately 1.90 per cent silicon; this amount of silicon is sufficient to give a very hot steel. On account of using a high percentage of steel scrap in the cupola charge, the percentage of carbon is cut down in the cupola metal, thereby shortening the blow in the converter. The theory which is also borne out by practice is that silicon will give the requisite amount of heat units by its combustion, whereas the combustion of the carbon, which results in the formation of carbon monoxide, gives off very little heat, barely sufficient to counteract the chilling effect of the nitrogen introduced with the blast and the radiation and conduction losses.

In blowing, a pressure of 4½ to 5½ pounds is maintained. The carbon flame is obtained usually about two to three minutes after the beginning of the blow, the total time per blow being 16 to 17 minutes.

Sometimes, due to carelessness upon the part of some of the men, the ladle and converter will not be hot enough for the first blow, and this will be indicated by the appearance of the flame. The judicious use of 50 per cent ferrosilicon at this stage will usually overcome the difficulty, which, however, should not be encountered.

Additions to Converter Metal

The service demands the use of four ladles, one for the cupola, one to receive the weighed charge of molten cupola iron, transferring it to converter, and two ladles used for pouring the castings. They are all lip-poured ladles, operated with worm-gearing, a bottom poured ladle being occasionally used for particular work. While one heat is being poured in the molds, the other casting ladle with the necessary amounts of ferromanganese, ferrosilicon and ferrotitanium in the bottom is being preheated under an oil-fired ladle heater.

About two minutes before the finish of the blow, the ladle is lowered on the platform scale, tared, and scale weights set for necessary addition of molten cupola iron used for recarbonizing. This amount of cupola metal for recarbonizing will vary according to the size of the charge entering the converter, the calculated losses in the converter and the desired final carbon. It is found that, ordinarily, one can estimate the losses in the converter quite closely, and thus vary the amount of cupola metal accordingly, but in cases of doubt, it is the practice to weigh the blown metal poured into the molten cupola iron. The regular practice, however, is as follows: After the necessary cupola metal has been added to the ladle, the crane swings this ladle over to the converter and the blown metal is emptied into the ladle. As soon as the vessel is turned down at the end of the blow, the vesselmen throws a couple of shovels full of dry sand on top of the slag in the vessel and then throws a brick on top of the slag just inside the nose of the vessel. When pouring the blown metal from the vessel into the ladle, the vesselman, by means of a long bar or rod resting on this brick, retains nearly all of the slag in the vessel, which slag is removed by turning the vessel upside down as soon as the ladle is swung out of the pit. The casting ladle is taken to the skimming floor, and there, by means of bent hooks, the small amount of slag is removed from the top of the steel. The steel should be hot enough at this stage to be able to hold it at least 10 minutes before starting to pour. Just before starting to pour the first mold, the thin film of slag adjacent to the lip is skimmed back, and a hot brick dropped on top of the steel, next to the lip. When pouring into the molds, a man keeps this skimming brick in place (close to the ladle lip), in this way effectually holding back the remaining blanket of slag.

In concluding the remarks concerning the converter practice, it may be well to emphasize a few points which may possibly not have been duly accentuated above:

1.—Careful selection and grading of melting stocks.
2.—Small cupola charges, thus obtaining uniform melting practice and uniform iron.
3.—Sufficient preheating of ladles and converter.
4.—Hot, quick blows.
5.—Careful skimming in converter and ladle
6.—Holding the steel in the ladle at least 10 minutes prior to pouring.
7.—The most important requisite of all, hot steel.

Open-Hearth Furnace

The open-hearth furnace used is, as previously stated, a 15-ton tilting furnace especially adapted for burning oil. It has but one set of checker chambers and one reversing valve. The size of the hearth is 20 x 9 feet.

The common practice in making the acid bottom is departed from somewhat inasmuch as an average of only four to six inches of bottoming sand is used. The remainder of the bottom and banks is built up of silica brick, with careful allowance made in the laying for expansion of each successive course. It is found that by making the bottom in this manner, much less trouble is experienced due to corrosive action of the slag or from excessive rust on steel scrap.

The purchased materials used in making up the open-hearth charges include pig iron with silicon, 1.50 to 2.25 per cent; manganese, maximum, 1.50 per cent; sulphur and phosphorus, not over 0.035 per cent Plate scrap and crop ends of suitable size and shape with sulphur and phosphorus not over 0.04 per cent also are employed. An important reason for the low-sulphur specifications in case of crop ends, is because this material is used in the cupola charge for converter steel, as previously described. Other materials used are shop scrap; risers; gates, etc.; ferrosili-

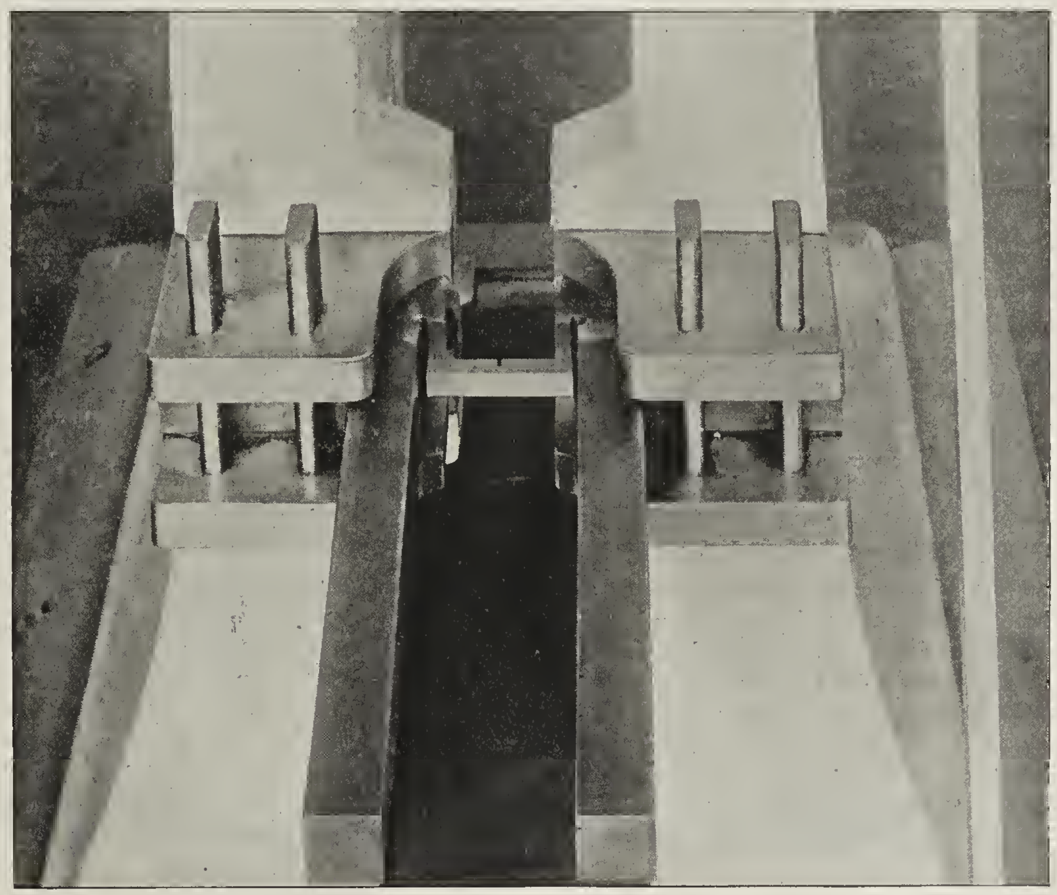


FIG. 6—DETAIL OF SPECIMEN HOLDER

con, ordinary 50 per cent grade; ferromanganese, 80 per cent grade; ferrotitanium, 15 to 18 per cent titanium content, 5 to 8 per cent carbon content; aluminum, the best grade and also No. 2 aluminum running 94 to 96 per cent. The following is a typical charge: Pig iron, 7000 pounds; shop scrap, 10,000 pounds; plate scrap, 5000 pounds; crop ends, 14,000 pounds. This will give a charge of approximately the following composition: Carbon, 1 per cent; manganese, 0.69 per cent; silicon, 0.60 per cent.

Order of Charging

First pig iron, next plate scrap and third heavy scrap are charged in the order named. A sufficient interval is allowed between charging the plate scrap and heavy scrap to permit the plate to soften under the heat and sag down in the furnace. It is then covered with one to 1½ barrows of bottoming sand to counteract the consequences from the rust, which results in excessive corrosive action on the banks.

A good flame during charging is maintained and to completely melt requires about 4½ hours from the time charging is begun. The furnace is charged by hand, requiring about seven men, besides the first helper. The time consumed averages about 1½ to 2 hours. From the time charging is begun until the heat is tapped averages almost six hours. The carbon in the bath, when charge is melted, will average 0.65 per cent, thus giving from 28 to 30 points of carbon to work on before adding the finals. It is attempted to adjust the flame and slag so as to eliminate one point of carbon in about three minutes. The use of iron ore in the bath to reduce carbon, after the carbon is below 0.55 per cent, is avoided if possible. In case the bath is lying too quiet and carbon not dropping fast enough, 100 to 200 pounds of crop ends are thrown in without increasing the basicity of the slag. The condition of the slag in the furnace and its character when poured into test molds for fracture tests are carefully observed. If it has the least indication of wildness and especially if the end of the heat is near, it is adjusted effectively by the addition of bottoming sand and a little loam, otherwise "blowy" castings will be the consequence.

The latter part of the refining operation is done entirely by heat, making the steel very hot and the slag as gray as possible, with a reduction of some of the silica in the slag to silicon. This reduction of silica will have to be estimated by the appearance of the test specimen and when the steel is hot enough and the carbon at about 0.38 per cent there is introduced enough ferrosilicon to give about 0.25 to 0.30 per cent silicon, the gas and air are shut off and damper lowered until carbon report is received from chemical laboratory. The ferromanganese is then added, stirring it through the bath as quickly as possible, and in from three to four minutes the heat is tapped out.

A pouring cup and runner large enough to take a full stream of metal without choking back is used in pouring all castings. Risers and gate openings are kept closed until just before pouring to prevent any dirt or foreign matter finding its way into the mold.

In making No. 3 cast steel, the attempt is made to tap at about 0.38 per cent carbon which, with the carbon taken up from the ferromanganese addition, will give a final carbon of 0.43 per cent in the heat. In other words, it is endeavored to catch carbon coming down, making due allowance for carbon increment from the ferroalloy additions.

In adding the finals there is used a variable amount of ferrosilicon, 350 pounds of ferromanganese, and 90 to 100 pounds of ferrotitanium. Sometimes a portion of ferrotitanium is replaced by aluminum. These are added to the ladle during tapping out. In tapping a heat, pieces of sacks or a piece of wood block is held in the tap hole sufficiently long for the metal bath to entirely include the tap hole, thus preventing the slag from running out in advance of the steel.

Great care is used in making up stoppers and adjusting the stopper in the ladle. A nozzle is used that is double burned and very true to shape and of a size recommended by the American Foundrymen's association for the 2-inch round faced nozzle. A standard grade of graphite stopper head is used, suitable for this nozzle. The stopper-head is keyed to the stopper-rod, being keyed up snugly and then released just a little. The stopper rod is 1¾ inches in diameter, made up with 2-inch sleeves.

Annealing

The paragraphs in the specifications governing the annealing of castings are as follows:

> "All castings shall be heated at least once to a temperature not less than 30 degrees Cent. above the AC_3 point. If the castings are then allowed to cool in the furnace, no reheating shall be necessary, but if they are drawn from the furnace and air chilled they shall be reheated to a suitable temperature. Rapid cooling as in oil or water will not be permitted without special authority.
>
> "All forgings and castings shall be heated for annealing, drawing, or other heat treatment as required as evenly as possible, and the operation shall be performed on the whole of a piece, never on a part only. During any annealing, drawing, or other heat-treating process, steel pieces should be held at the desired temperature for a sufficient length of time to insure that the heaviest part of the piece shall be thoroughly soaked at this temperature."

The furnace employed at Watertown arsenal consist of one car bottom annealing furnace, 25 x 16 x 7 feet, with track at foundry-floor level. This unit is fired from the side into a combustion chamber, with four high-pressure oil burners; the second furnace, 15 x 7 feet 10 inches x 8 feet, is also of the car-bottom type, the tracks being in a pit bringing the car bottom to the foundry level. This furnace is also fired from the side into a combustion chamber and is equipped with two high-pressure oil burners.

Platinum Couples Employed

Temperature control is maintained with platinum couples which are connected to Leeds & Northrup recorders. The couples and recorders are carefully checked each week and an accuracy of 5 degrees Cent. is maintained.

The standard annealing treatment for No. 3 steel is as follows: Heating to 950 degrees Cent., holding for four hours followed by air chilling. After the completion of the chill the castings are drawn at 500 degrees Cent. This subsequent draw is considered very essential to relieve any internal strains which might be present. This temperature, 500 degrees Cent., is not high enough, however, to produce any appreciable readjustment of structure.

All No. 2 castings are annealed by heating to 900 degrees Cent., holding at this temperature for four hours, followed by furnace cooling. The work is very frequently going through the foundry in such a manner that it is not feasible to separate the No. 3 and No. 2 for the annealing operation. In this case, No. 2 is given the No. 3 treatment, namely, the air chill and draw.

The specifications state that rapid cooling such as water or oil will not be permitted without special authority. This clause appears to be justifiable. To allow promiscuous quenching operations to be carried out on all classes of work without knowing the equipment of the contracting parties might lead to serious trouble. Coupons representing small work might be satisfactorily quenched whereas the castings represented thereby might not be quenched in a satisfactory manner. Furthermore, the dangers of cracking are always present and it would seem essential for the government to know not only the facilities but also the experience of the contractor in conducting this class of treatment before permission could be granted to heat treat in this manner.

The principal special treatment which is sometimes employed at Watertown arsenal consists in a prolonged anneal, six to eight hours on small sections, just above the AC_3 point; this treatment has often been successful in improving the ductility of heats which have been given the standard No. 2 or No. 3 treatment. In fact, it is never used unless the standard treatment has failed to produce the desired results and in accordance with specifications, could not be given unless the castings had previously been annealed at a higher temperature.

Recourse is also had at times, in the case of some alloy castings, to a treatment similar to the standard No. 3. The first operation consists of an air chill from 1050 degrees Cent. followed by a draw at approximately 775 degrees Cent.

In certain exceptional cases either water or oil quenching from temperature ranging from 800 degrees to 900 degrees, followed by drawing, at temperatures from 600 to 700 degrees, has been resorted to.

The following figures taken from the results of tests on heats cast in April, May or June may be of some interest:

Month	No. of casting heats converter	Per cent passing 1st test	No. of heats cast O. H.	Per cent passing 1st test
April	32	86	8	87½
May	50	60	11	90
June	55	80	10	80

The per cent of heats passing the first test in May from the converter steel was lower than usual. This was due to the fact that a number of alloy steel heats were made which did not comply with the specifications after the first treatment. This specification was 55,000 pounds elastic limit, 90,000 pounds tensile strength, 15 per cent elongation and 25 per cent contraction.

In compiling the above table only those heats, all the castings of which passed the first test, were counted. If a second test was necessary, although due to a defective first specimen, the heat was considered as not passing the first test.

When a heat fails to pass the first test it is the duty of the laboratory to check the chemical analysis, make a microscopic examination of the specimens which failed and then recommend a second treatment. If, for example, the first test showed the following results: 48,000 pounds elastic limit; 90,000 pounds tensile strength; 11 per cent elongation and 14.5 per cent contraction; the second treatment would probably consist of a long anneal just above the critical range followed by furnace cooling. If the low ductility previously mentioned was due to too high carbon, which can easily be determined by laboratory examination, the second treatment would in all probability reduce the elastic limit and tensile strength increasing at the same time the ductility.

If the elastic limit and tensile strength were low on the first test while the ductility was high, the heat would probably be again air chilled but additional care taken in arranging the castings on the car so as to insure their receiving a good circulation of air when pulled from the furnace.

In meeting the prescribed physical requirements, one particular type of difficulty is often encountered to which special emphasis should be given. The following illustrations will bring out this point: Fig. 1 shows the microstructure of a specimen of cast steel at 50 and 500 diameters, respectively. This material represents the attempt of a commercial foundry to meet the government specifications for cast steel No. 3. It will be noted that this material is deficient in ductility. Attention is also invited to Fig. 2. Here again the chemical composition, elastic limit and tensile strength are satisfactory but the elongation and contraction are very poor. Fig. 3 shows a specimen which was entirely satisfactory.

The explanation of the difference in behavior of these different heats under test is quite simple but it is beyond the scope of present methods in chemical analysis. Microscopic examination shows that both the heats failing in ductility are contaminated with a great deal of slag.

Attention is again invited to Figs. 1 and 2. The micrographs at 500 diameters show an almost complete slag network which surrounded the original austentite grains. This network is very effective in preventing the development of proper structure by annealing and, furthermore, produces decided cold shortness and lack of ductility.

The specimen shown in Fig. 3, although far from being as free from slag as might be desired, shows a much better structure. A continuous slag network is absent and hence the better ductility. The specimens shown in Figs. 1 and 2 were undoubtedly poured from cold steel. The slag particles present in the bath at the conclusion of the blow were effectively trapped. This, as mentioned above, is due to cold metal, the slag particles not having opportunity by virtue of their specific gravity to rise to the surface.

Fig. 3 shows a specimen having a decidedly better structure with regard to slag. This test was poured from a hotter blow than either Fig. 1 or Fig. 2. The slag particles have coalesced and the network is destroyed. If this metal had been still hotter, these coalesced particles would not have been trapped.

Although the foregoing may be regarded as a hypothesis having no place in an ordinary steel foundry, it is felt that enough evidence has been gathered to remove it from the realms of theory to the domain of facts.

It might be well before passing from this portion of the discussion to state that when a specimen fails to pass the requirements of ductility and has a structure similar to Figs. 1 and 2, further annealing treatment is considered useless. The trouble is cold metal. Annealing medicine cannot cure such a disorder and the patient is doomed.

Investigations of difficulties are constantly being made and, at the present time, every effort is being put forth to improve the product of the foundry. One of the tests which has been and is now useful in this respect is described below for the benefit of those who are not familiar with it.

Fig. 4 shows a side view of the Charpy impact machine and Figs. 5 and 6 end views of the same instrument with the specimen in place for testing. This illustration also shows the form of a specimen used. In operation, the pendulum is elevated to a fixed height and then released. The specimen is struck a sharp blow and depending upon the amount of work absorbed by the specimen, the pendulum is retarded by a certain amount which is determined by the excess angle. The foot pounds absorbed by rupture can then easily be computed.

It is the practice to record this as foot pounds absorbed per square inch, using the data obtained from the small specimen in the same manner as computing the results from a standard tensile specimen. This is not rigidly true as the results obtained from different size notched specimens subjected to shock do not follow the simple laws of similarity which hold for tensile specimens. However, this method gives the significance of comparative figures which are understood by all concerned.

The following experiment serves to illustrate the effect of varying heat treatments upon the shock strength of plain cast steel of approximately 0.30 per cent carbon and 0.62 per cent manganese. After being annealed at 900 degrees Cent. for two hours, water quenched and drawn at 650 degrees Cent., an average of seven specimens showed 185 foot pounds absorbed per square inch. After being annealed at 850 degrees Cent. for two hours, air chilled and drawn at 500 degrees Cent. for two hours, an average of eight specimens showed 153 foot pounds absorbed per square inch. After being annealed at 900 degrees Cent. for two hours and furnace cooled, an average of eight specimens showed 146 foot pounds absorbed per square inch. It will be noted from these results that the water-quenched and drawn casting is superior to any other treatments as far as shock is concerned. The air-chilled casting is also superior to the furnace cooled.

Many experiments such as these are being conducted and as previously stated in this paper, it is thought that ultimately high-grade alloy castings will replace many parts now being made of forgings. Although the very term casting brings up unpleasant thoughts in the minds of many designers, it cannot be disputed that by the very nature of the method of manufacture, a casting has one decided advantage over a forging. This advantage lies in the fact that the physical properties of a casting are the same in all planes if the annealing and casting operations have been properly carried out. It is a matter of common knowledge that the physical properties of a forging are widely different in different planes. In some exaggerated cases, the elongation may be 22 per cent in one plane whereas it is practically zero in a plane at right angles. As long as suddenly applied stresses are confined to the plane having good ductility, failure will not ensue, but if by any chance they occur in the planes having poor ductility, failure is almost certain. The static test comes far from telling all of the truth, especially when the specimens are taken in one direction only. The Charpy impact test will pick out these cases of absence of ductility in certain planes and it is for this reason that its use has been successful.

In view of results obtained on the Charpy impact machine, investigation at the Watertown arsenal leads to considerable optimism in the eventual replacement of many high grade forgings with castings. Furthermore, this replacement will result in considerable saving of time and money, when such castings can be produced on a commercial basis.

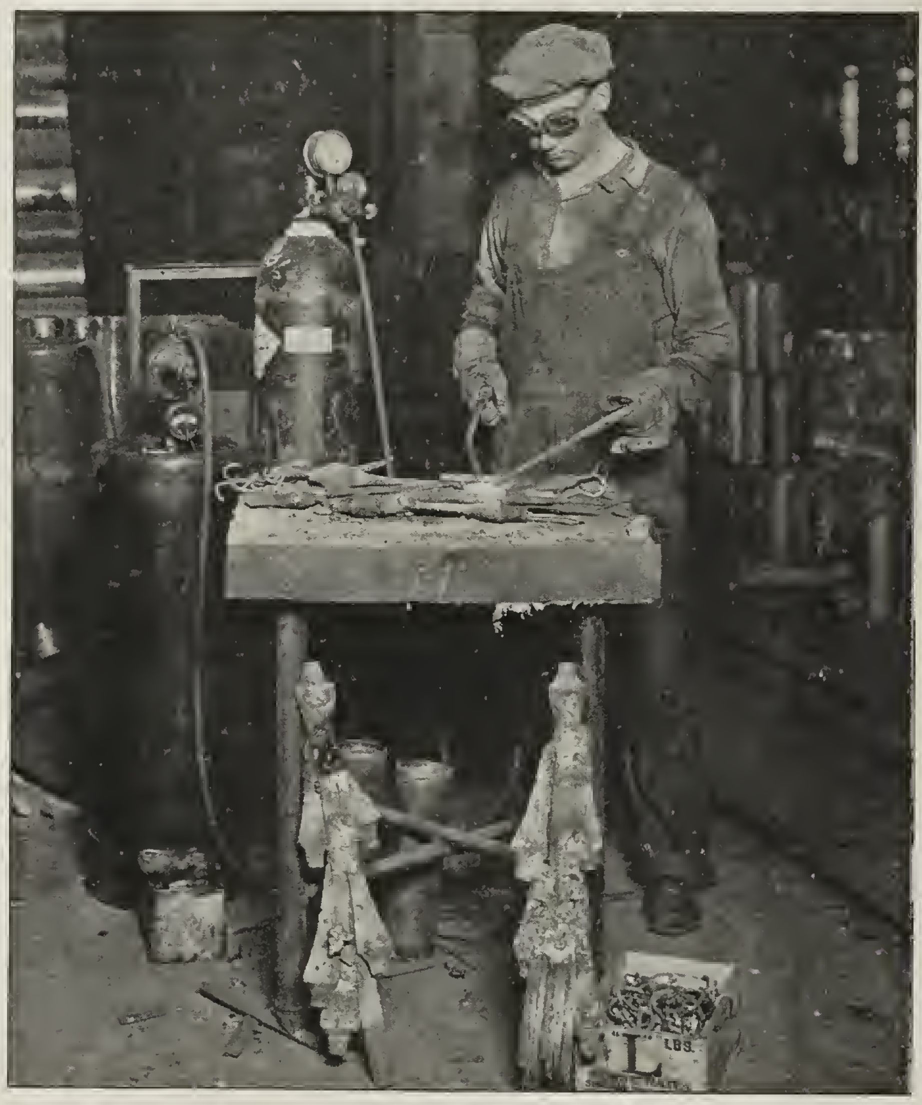
Scrap Nickel Anodes Reclaimed by Welding

The practice of utilizing every pound of nickel anodes for service by welding the scraps together is saving considerable money in many plating departments and establishments. Until recent years, many firms sold their worn anodes as scrap for want of a thoroughly satisfactory method of utilizing them. This was always a source of considerable loss to platers for the scraps often represent a considerable portion of the original anodes and their junk value is less than one-half their original cost. By welding the scraps together by the oxy-acetylene process, every pound of the costly metal is utilized for plating purposes at a trifling welding cost.

The practice of welding scrap anodes usually is as follows: The worn anodes, as they are withdrawn from the tanks, are turned over to some workman who handles the welding. A scrap of suitable size and shape is selected as a hanger and other scraps are tacked to it by welding until the desired size and weight are secured. The tacking consists of melting the scraps, at the point of welding, by the heat of the oxy-acetylene flame, allowing them to run together or fuse into one piece. The tacking of a joint requires but a moment as the temperature of the oxy-acetylene flame, which is approximately 6300 degrees Fahr. causes the metal to fuse quickly.

No flux is used as the metal runs together and where necessary another piece of scrap nickel is used as a filling rod.

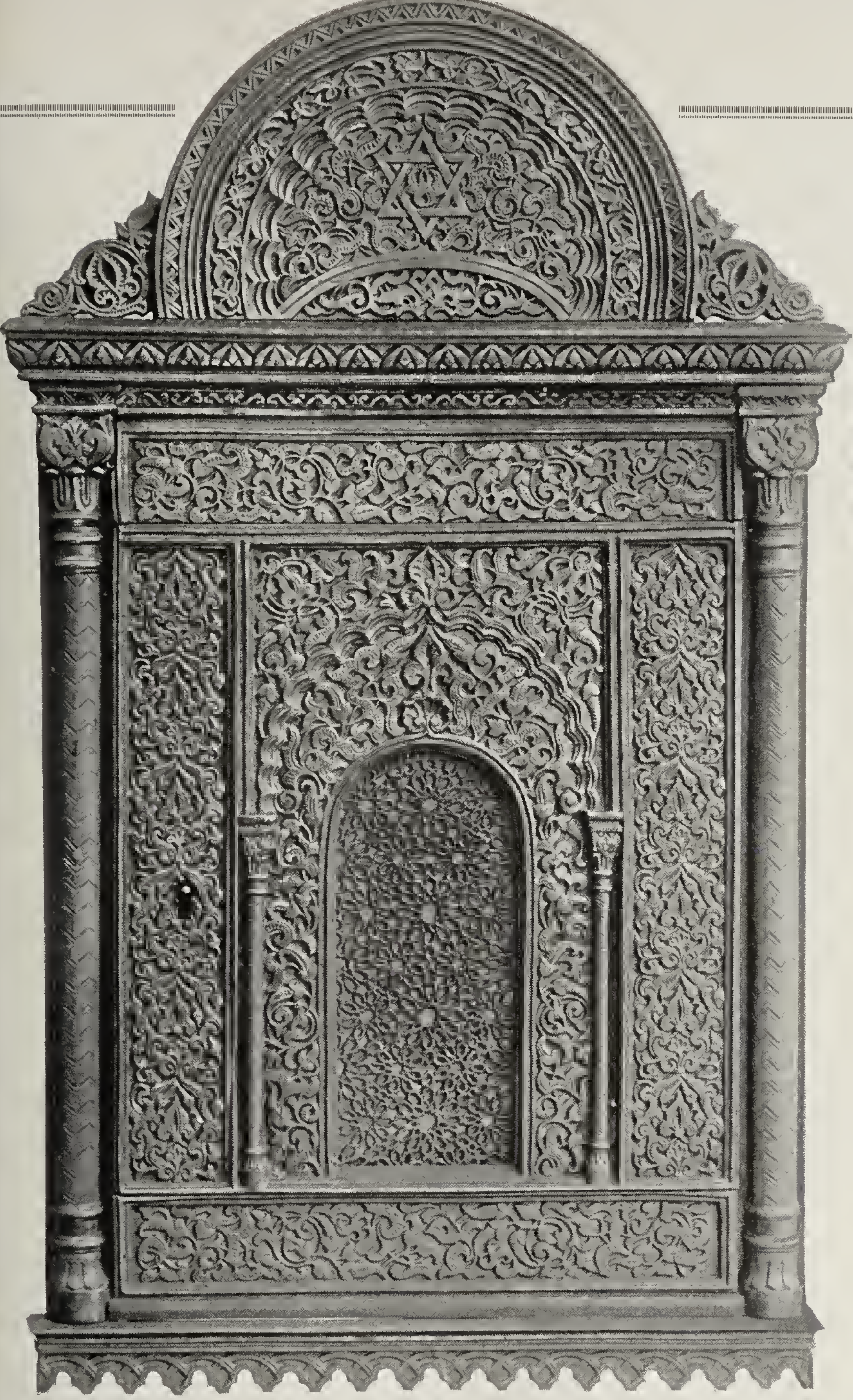
The oxy-acetylene flame is also used to remove the brass hooks from the scraps, the solder melting rapidly, leaving the pure anode to be welded.


WELDING SCRAP ANODES BY OXY-ACETYLENE METHOD

Several other methods of utilizing scrap anodes have been tried, but with uncertain results. The method of fastening them together with rivets and similar methods are seldom thoroughly dependable because of uncertain conductivity. It is impracticable for anyone but the manufacturer to re-melt and re-pour anodes because in so doing the composition is changed. A decided advantage in welding the scraps together is that the original composition is not changed and the fused joints insure conductivity equal to that of new anodes. Another advantage is that no skill or experience in the art of welding is required to weld scrap nickel anodes. The accompanying illustration shows the welding of scrap anodes by the Prest-O-Lite process of oxy-acetylene welding. Welded anodes are shown in the foreground.

In these days of high nickel prices and an impending shortage, the reclamation of scrap anodes at such a trifling cost will appeal to those alert for possibilities in keeping down manufacturing costs.

The Macleod Co., Cincinnati, manufacturer of sandblast equipment, metal melting furnaces and other foundry accessories and supplies, has completed extensive additions to its plants and recently has increased its capital to $100,000. This company has been established for more than 20 years and has built up a large trade in foundry equipment of all kinds.



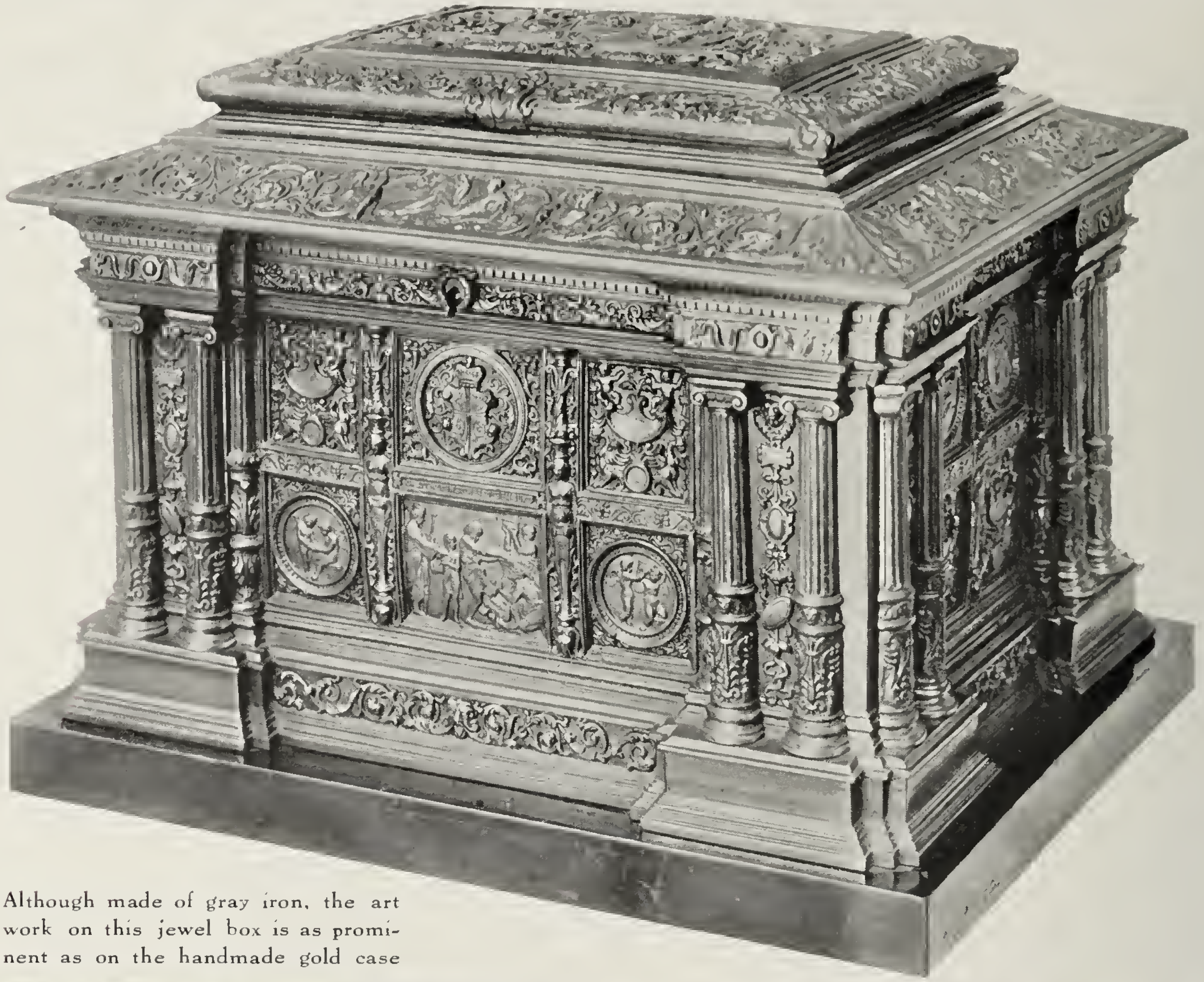
In appearance, this view of a gray iron reproduction closely resembles the finest of hand wrought craft work—The original is modeled after a cloister door in a southern German cathedral

Unique Gray Iron Castings

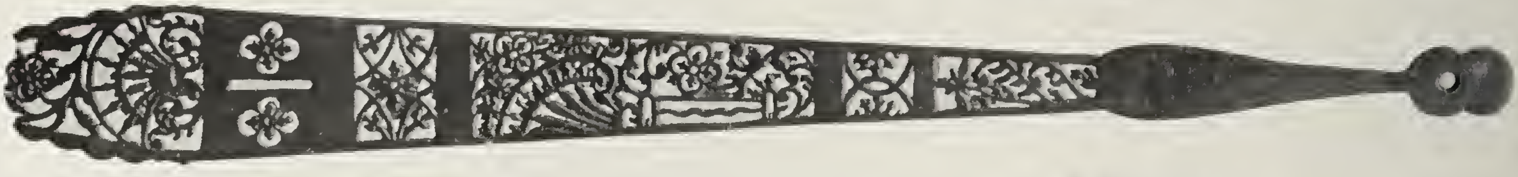
German Foundrymen Skillfully Reproduce Artistic Gold and Silver Craft Work

IRON is seldom associated with gold, silver or even the more common metals such as copper and bronze as a medium for the skilled artisan to express his creative genius in definite form. The illustrations on this and the following page, however, show what may be done with this utilitarian metal when it is handled by skilled foundrymen. The castings illustrated are reproductions made of high phosphorus iron by German molders. Although most of the pieces are not of original design, the craftsmanship shows unusual technique of execution. The German artisan is a clever imitator, but he lacks the true artistic sense. He has an eye for bold and striking decorative effects but fails to appreciate the value of contrast. The castings are part of a collection of imported art pieces owned by John A. Penton, of Cleveland.

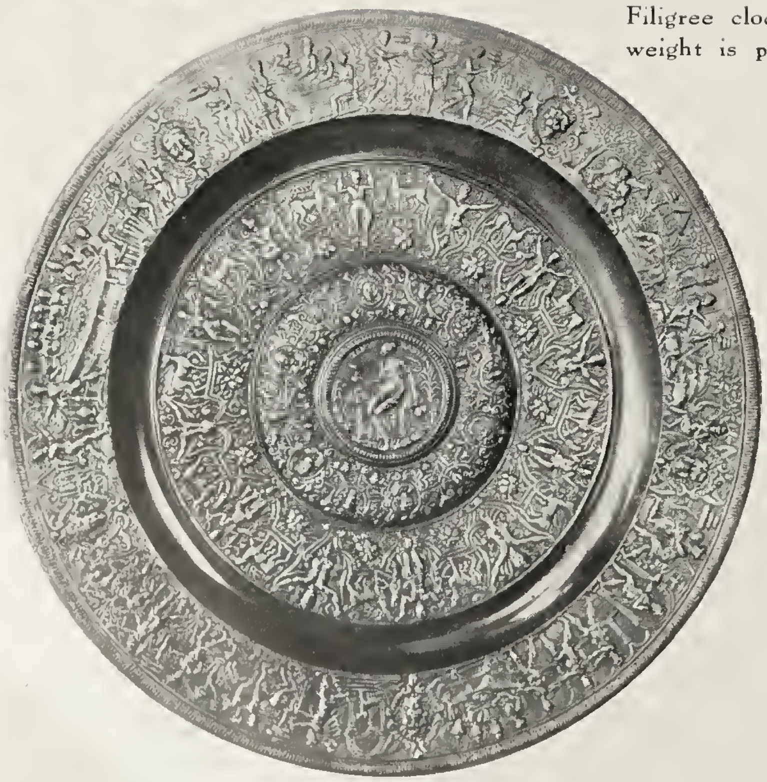
Plaques of characteristic Teutonic design

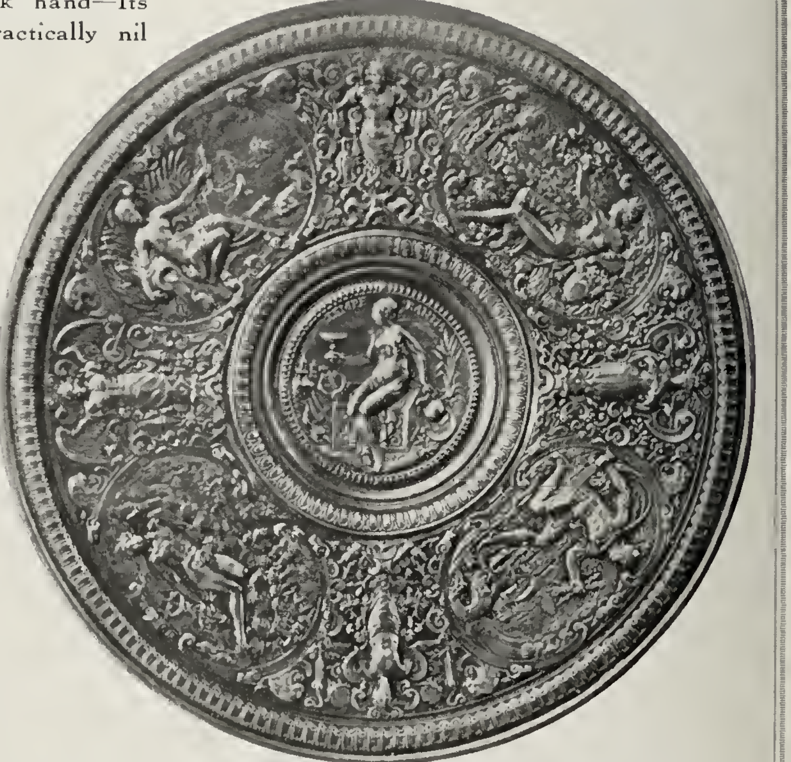


Although made of gray iron, the art work on this jewel box is as prominent as on the handmade gold case



Filigree clock hand—Its weight is practically nil





The two plaques are typically Teutonic is design—It will be noted that the central figures on the two are identical—Historical epics are represented by the single characters and groups—The figures around the borders illustrating warriors of old are particularly interesting because they indicate the influence of centuries of conquest upon the German artist

Pulverized Coal For Melting Malleable Iron

Comprehensive Tests Reveal a Number of Important Advantages for Powdered Fuel—Hand Firing and Mechanical Stokers Not Satisfactory

By W R Bean

THE need for some improved method of firing air furnaces used in melting malleable iron which will be less laborious and more dependable than the present method of hand firing will be readily acknowledged by many who have had experience in this direction. While more is known today than in past years regarding the way in which hand firing of the malleable melting furnace should be done, it is questionable if there has been any decided improvement in the results obtained, due to the class of labor on which it is necessary to depend for work of this character.

Aside from the limited use of the open-hearth furnace in melting malleable iron; a very small number of furnaces fired with oil or natural gas; and the recent application of the electric furnace as a unit in the melting and refining process; the use of which, however, will no doubt be confined for some time to come largely to new foundry plants, we are dependent upon gas coal as the fuel for melting malleable iron, the firing of which may be accomplished by hand, by mechanical stoker and by introducing coal in pulverized form.

Hand Firing Cannot Be Uniform

The essential factor in the burning of any fuel is the proper proportioning of air to the combustible available for burning at a given time. It is obvious that with hand firing there can be no uniformity in this essential feature because the amount and size of the combustible available is constantly varying. When coal is thrown on a hot fire bed, the volatile products are rapidly driven off with the result that there is not sufficient oxygen present for complete combustion, the supply of air being constant, or if there is sufficient for this condition there must of necessity be an excess as the coal burns down between firing periods.

The mechanical stoker has been tried out on the air furnace many times, but in only a few instances has the equipment installed remained in service for any considerable period. At present I do not know of any air furnaces, melting malleable iron, which are being fired with a modern type mechanical stoker, although in one plant there are several furnaces used for melting cast iron for special purposes, which are being successfully fired with mechanical stokers of the underfeed type.

The figures on pulverized coal firing, included in the accompanying table, cover a number of heats melted with pulverized coal in a furnace at the Deering works of the International Harvester Co., Chicago. Thirty-six heats in all were taken, as will be seen by reference to the tabulated results. These were not sufficient to determine either the practicability or impracticability of the method, but the results obtained appeal to me as having sufficient merit to justify some progressive organization in carrying the matter further, especially in plants where pulverized coal is now being used for annealing purposes.

Fundamental to success in the operation is the kind of fuel used and this cannot be very different than that which it has been found necessary to use for best results in hand firing. Coal high in volatile combustible matter—30 per cent or over—is very desirable and the ash content should be below 10 per cent and the sulphur below 1.5 per cent. However, slack coal from the screened coal generally used for hand firing air furnaces can be satisfactorily employed, the principal objection being the higher ash and sulphur content.

Just how detrimental the deposit of ash over the charge before melting down and over the bath after melting will be, is a question that is yet to be determined. With a suitable combustion chamber and burner this probably would not cause serious trouble. However, there is a considerable total quantity in the fuel to be cared for. For example, in a 20-ton heat, assuming 800 pounds of coal per ton of iron and 10 per cent ash, there would be 1600 pounds of ash to dispose of and it is a matter of importance as to where this is deposited. Obviously it is advantageous to deposit it as much as possible in the combustion chamber and with a view to readily disposing of this deposit, one company in the pulverized coal equipment business has developed a combination of low-pressure feeder, burner and combustion chamber, whereby the majority of the noncombustible is precipitated before the heating zone of the furnace is reached. The point of deposit of ash is dependent upon a number of factors among which are fineness of coal, point and completion of combustion, and velocity resulting from draft or pressure.

There is one point of importance in which the coal may to advantage be different from that used for hand firing, namely, that coal in which the fusing point of the ash is low has certain advantages over coal in which the ash has a high fusing point. Ash with a low fusing point will deposit earlier as slag. This is particularly advantageous for plants located in the west or middle west where the coal available at lowest cost generally has ash of a low fusing point, although otherwise suitable for melting furnace firing by hand. In the matter of sulphur content of coal I have been unable to find any difference in the effect of this element on the metal between one method of firing and another, since it volatilizes in any case and passes over the bath with the products of combustion.

The Degree of Pulverizing

For quick combustion and high temperature, coal should be pulverized to a fineness of not less than 85 per cent of the total through 200 mesh and 95 per cent of the total through 100 mesh. Some operators found it advisable in open-hearth practice to pulverize to an even higher degree of fineness. The advantage to be gained from this will be found to exist equally with the air furnace and the open-hearth furnace, since high temperature is the end sought in both cases. Coal for pulverizing must be thoroughly dry, 1 per cent or under in moisture and preferably as low as 0.50 per cent. This is necessary not alone for the proper mixing and burning of the fuel, but from the standpoint of cost of pulverizing. The cost of pulverizing is a variable factor in which many different elements, particularly the cost of power, are involved and can only be stated definitely under known conditions. Some large plants are pulverizing at a cost

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The author of this paper, which was presented at the Boston meeting of the American Foundrymen's Association, is metallurgist, Naugatuck Malleable Iron Works, Naugatuck, Conn.

of approximately 25 cents for each ton.

The furnace on which the experiments were conducted was of good general design with stack of ample proportion. In making the change from hand firing to pulverized coal firing only minor alterations were required. The fire-box was converted to a combustion chamber by increasing the length to give sufficient travel of the coal and air mixture to get good ignition before impingement of the flame against bridge wall, which was allowed to remain as in hand-fired practice. The grates were covered over with about 6 inches of cinders to form a hearth for deposit of the slag from the ash in the fuel. The length of the melting chamber from bridge wall to bridge wall was 24¾ feet, and the furnace was 7 feet wide at the front. The side walls were parallel for 11 feet back of the front bridge wall, from which point the furnace narrowed to 5½ feet at the rear flue or neck, the opening through which was approximately 420 square inches in area. The area of stack inside of lining was 1385 square inches.

Results of Tests With Pulverized Coal

Heat No.	Date 1914	Charge, pounds	Coal per ton of iron, pounds	Duration of heat, hr.	Duration of heat, min.	Time per ton melted, min.	Silicon loss, per cent	Furnace arrangement, No.	Condition of furnace
1	Mar. 28	12,000	.....	5	6	50	....	1	Cold
2	Mar. 30	12,000	.....	7	15	71	....	2	Cold
3	Apr. 4	12,000	1,120	4	15	42	0.51	3	Cold
4	Apr. 6	20,000	1,536	8	15	49	0.58	3	Cold
5	Apr. 7	20,000	1,198	..	..	..	0.44	3	Cold
6	Apr. 8	20,000	1,192	7	25	44	0.43	3	Cold
7	Apr. 8	20,340	874	5	40	33	0.15	3	Hot
8	May 18	20,000	1,066	9	0	54	0.49	4	Cold
9	May 20	20,000	1,134	7	30	45	0.51	4	Cold
10	May 21	23,000	1,508	..	..	..	0.48	4	Cold
11	June 8	20,300	1,536	9	55	57	1.15	5	Cold
12	June 9	20,350	1,198	9	0	52	1.21	5	Cold
13	June 10	20,000	1,368	8	30	51	0.92	5	Cold
14	June 12	20,210	1,324	8	30	50	0.32	6	Cold
15	June 16	20,000	1,754	9	15	55	0.51	7	Cold
16	June 19	20,145	1,558	7	15	42	0.31	8	Cold
17	June 22	20,000	1,216	6	30	39	0.34	9	Cold
18	June 23	20,000	1,346	..	..	..	0.49	9	Cold
19*	June 24	20,000	1,346	..	..	..	0.58	9	Cold
20	July 15	20,000	1,696	9	15	55	0.83	10	Cold
21	July 16	20,000	1,682	7	0	42	0.87	10	Cold
22	July 17	20,300	1,056	5	30	32	0.41	10	Cold
23	July 20	20,000	1,140	6	13	37	0.48	10	Cold
24	July 20	20,340	794	4	52	28	0.39	10	Hot
25	July 21	20,760	1,250	6	0	36	0.44	10	Cold
26	July 21	24,610	822	4	43	23	0.34	10	Hot
27	July 22	20,000	970	5	0	30	0.24	10	Cold
28*	July 22	20,000	970	4	15	25	0.30	10	Hot
29	July 23	20,000	1,056	5	15	31	0.42	10	Cold
30	July 23	20,000	966	3	50	23	0.47	10	Hot
31	July 27	20,200	1,322	6	34	39	0.80	10	Cold
32	July 28	30,000	1,124	8	17	31	0.66	10	Cold
33	July 30	20,000	922	4	20	26	0.46	11	Cold
34	July 31	24,500	760	4	40	22	0.43	11	Cold
35	July 31	24,000	620	3	37	18	0.26	11	Hot
36	Aug. 4	20,000	800	4	10	25	0.43	12	Cold

*Indicates coal weights were not separated between heats Nos. 18 and 19 and Nos. 27 and 28.

Pulverized coal fires, with coal of proper dryness, fineness and volatile content, are very readily started, it only being necessary to light a small quantity of oily waste in front of a burner and start the coal and air feeds. With any reasonable amount of care, there need be no smoke or coke formed where there is sufficient flame-way in starting up a malleable melting furnace and, of course, there is none after the furnace and charge become hot. To prevent smoke and coke in starting, it is necessary to burn with a short flame and get complete combustion in the front of the furnace.

It will be well to have clearly in mind the distinction between a pulverized coal burner and a pulverized coal feeder or controller. The function of the latter is to supply uniformly to the burner the quantity of coal which it may be desirable or necessary to burn to produce the required temperature. The mixture of coal and air takes place in the burner, combustion beginning soon after this mixture enters the combustion chamber, the exact point at which this takes place being dependent upon velocity, air proportion and other factors.

Turning now to the figures in the table at the end of this paper, we find results, in coal consumption per ton of iron, melting time and silicon loss, all the way from poor to exceptionally good, the latter applying particularly to heats Nos. 34 and 35. There are 12 different furnace arrangements indicated under the heading, "Furnace Arrangement". In some cases the change between one arrangement and another was only slight, yet it was considered of sufficient importance to record; in other cases the change was a radical one.

Furnace arrangement No. 11 produced the best results, the figures for heats Nos. 34 and 35 comparing favorably with the very best practice under hand firing methods. The change from arrangement No. 10 to arrangement No. 11 did not in any way involve the coal feeding or burning equipment, but was one of furnace construction. It consisted of lowering the roof of the furnace so as to bring the nozzle outlet of the top blast into the proper relation with the bath and directing this in such a way as would bring the point of highest temperature in direct contact with the metal and in providing sufficient volume of air through the top blast.

In judging the coal consumption figures it should be remembered that many of the heats were single heats only, taken after the furnace had been idle for days or for weeks and that a large amount of fuel was required to bring the furnace up to the temperature that would exist in a furnace in regular operation for one or two heats a day.

Troubles During Hot Months

The period which is of greatest interest because of the more nearly continuous operation is that from July 15 to 31 inclusive with furnace arrangement Nos. 10 and 11, heats 20 to 35, inclusive. During this period we tried to get the proper proportion of air and fuel and in this we were only partly successful because arrangement could not be made to continue the test for a period sufficiently long to work the matter out to a final conclusion. There was, during this time, a fairly regular decrease in coal per ton of iron melted, in time per ton melted, and in silicon loss from oxidation during the heat. The relation between coal per ton and silicon loss is of particular interest. In looking over these figures in light of more recent experience, it is evident that the high coal consumption was largely the result of excess air, although there was not much difference in the operation under furnace arrangement Nos. 10 and 11.

Heats Nos. 1 to 35, inclusive, were taken with all of the air for combustion supplied under pressure. Heat No. 36 was taken with something more than half the air taken in by induction, only the top blast and the air necessary to convey the coal into the burner being supplied under pressure. Not much can be based on the results of a single heat, but from what has been accomplished in locomotive and stationary boiler firing under the induced draft system, I consider this method for air furnace operation one well worth considering.

The use of pulverized coal on the air furnace brings to my mind two other matters which may be well worthy of serious consideration. Waste heat boilers may be more generally employed because the method of firing lends itself readily to the maintenance of a low fire between heats to maintain the boiler capacity required in the majority of malleable foundries during the off hours of operation. Furthermore, where the steam supply is lacking, combinations of waste heat and direct firing are now being installed to provide a 150 to 200 per cent of nominal horsepower rating output, which is most advantageous in plants where power is required for other than foundry operation. There are, no doubt, some and perhaps many localities in which an agreement for exchange of power with local power distributors could be effected which would result in a material saving as compared with the present cost of air furnace melting and power supply. The other point which presents itself is the possibility of using silica brick in furnace lining, the ability to keep a furnace hot continuously making the use of this kind of brick practical.

The air furnace as at present operated is admittedly a wasteful piece of equipment, yet it lends itself better to the varying requirements of the average malleable foundry than does any other type of melting furnace and while electric melting, or more correctly perhaps, electric heating of malleable iron may make further progress, the air furnace is destined to continue to be the principal melting unit in the average mallable foundry for some years to come.

One of the achievements credited to the late David H. Browne, chief metallurgist of the International Nickel Co., is the practical application of pulverized coal firing to reverberatory smelting furnaces. I know that there are several installations in successful operation in the copper and zinc refineries and it would seem that the advantages to be gained in the malleable industry should be fully as great.

The probable or at least possible advantages to be derived from pulverized coal firing of the air furnace may be summed up as follows:

The elimination of the exhausting labor of hand firing, permitting the employment of more intelligent men in operating the furnace.

The elimination of the clinker problem which at this time is unusually serious owing to conditions existing in the coal market.

A reduction in the cost of fuel over present hand-fired practice by improved combustion, and in some cases by the use of lower-priced fuel.

The elimination of smoke.

A more advantageous use of waste-heat boilers.

A reduction in cost of furnace maintenance by the use of silica brick.

Book Review

The Principles of Iron Founding, by Richard Moldenke; cloth; 517 pages, 6 x 9 inches; published by the McGraw-Hill Book Co., Inc., and furnished by THE FOUNDRY for $4 net.

The history of iron founding is so closely bound up with that of the human race that a man need not necessarily be an iron founder to be interested in that industry. From the days of Tubal Cain, when we first find historical mention of the manufacture and use of iron, that metal has occupied a position of ever-growing importance in the life of man. Today we take its presence so much as a matter of course, that only a sudden cutting-off of the supply could make us realize how very important its use has become.

"The Principles of Iron Founding" is, therefore, a book devoted to a subject very worthy of study, both by the foundryman, who can make practical use of it, and by the layman who has a desire for knowledge for its own sake.

The opening chapter of the book traces the manufacture of iron back past its earliest recorded history into the period which, according to the author, is wrongly designated as the "bronze" age. "That the 'bronze' age is really a misnomer must be evident from the fact that the metallurgy of iron is much simpler than that of copper. Primeval man must have been aware of this situation and have used iron implements at least as early as bronze ones, if not before. The only records of these times are furnished by the content of burial places, and it would indeed be strange if on opening such mounds any iron had escaped the solvent action of the ground waters of passing ages. Hence remains of bronze alone have been discovered."

The efforts of the ancient iron masters, or "furnace men" are then described, their labors resulting now in failure and now in success. The story is told briefly but effectively, and the various threads leading through France, England, Germany, Russia, and finally this country, are followed up to the present day. Having started with Tubal Cain, we find at the end of the chapter the names of W. J. Keep, professors W. C. Unwin, F. Osmond, H. M. Howe, and A. Sauveur, and others equally familiar and important.

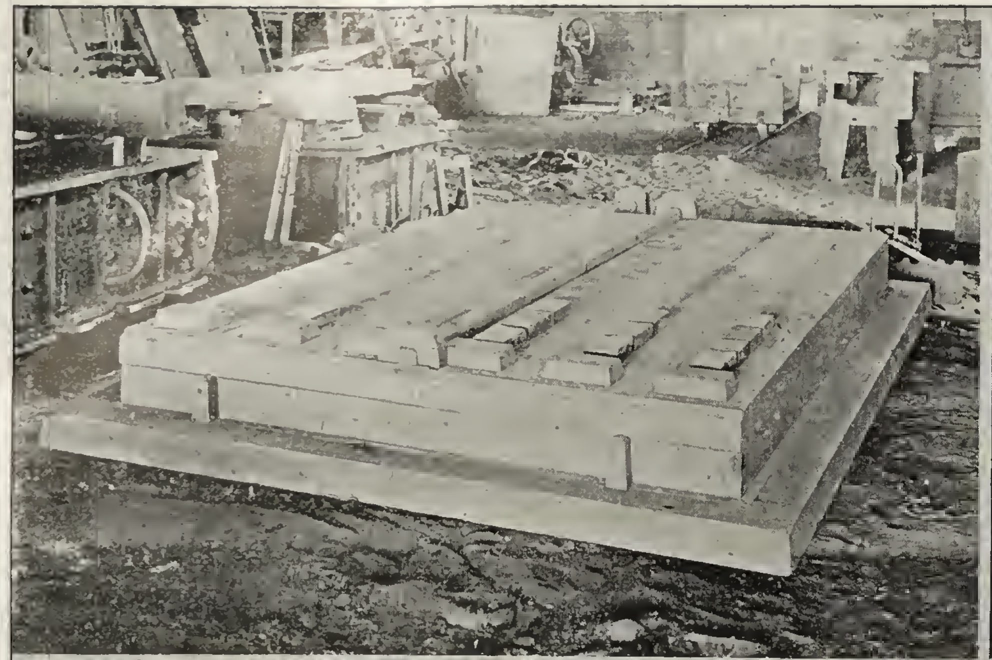
The historical foundation of the book laid, the author then proceeds to build the rest of the structure in logical sequence. Chapter II discusses the relation of the industry today to the other important activities of man. The good foundryman of necessity is informed about allied industries "so that he may be in a position to buy economically and timely, be able to detect inferiority in supplies bought from personal knowledge of the processes involved in their manufacture, know the problems confronting his customers, and thus be able to serve them intelligently."

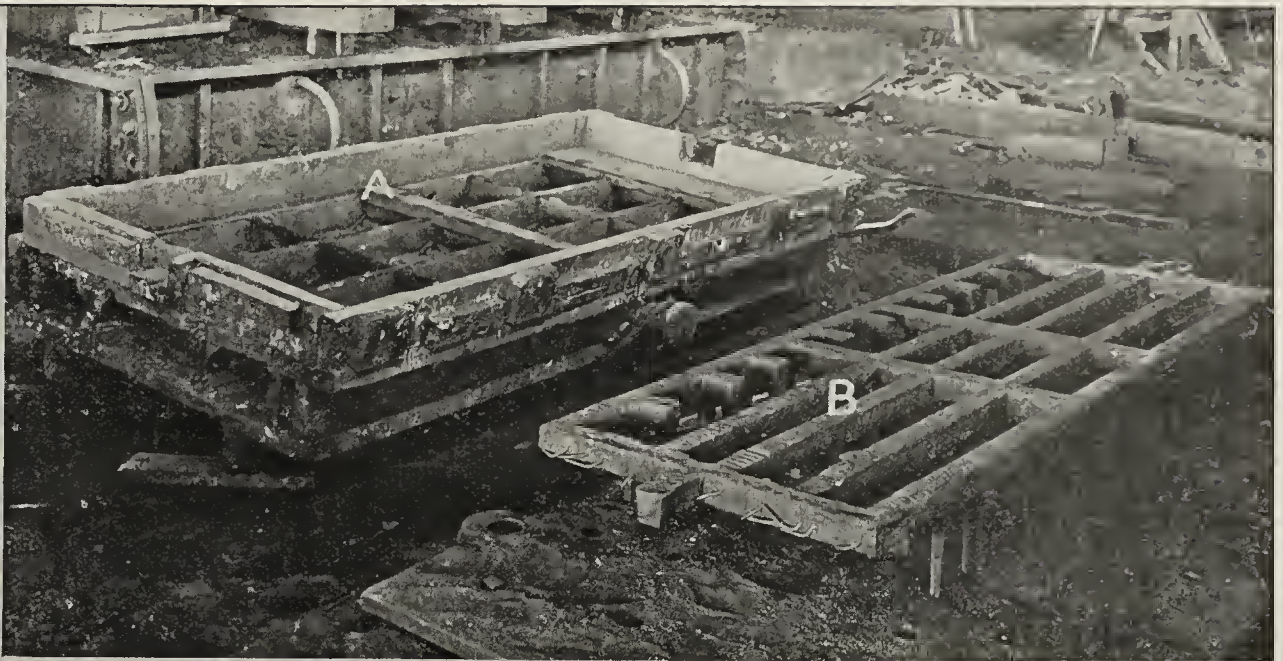
In addition he must study other broader problems connected with his business. He must have some knowledge of the relation of the foundry to commerce and finance, and on interfoundry relations. He must be prepared to cope with labor problems and other questions relating to internal policy. The organization of the plant is discussed in Chapter III. The main essentials of a foundry organization are pointed out and briefly described.

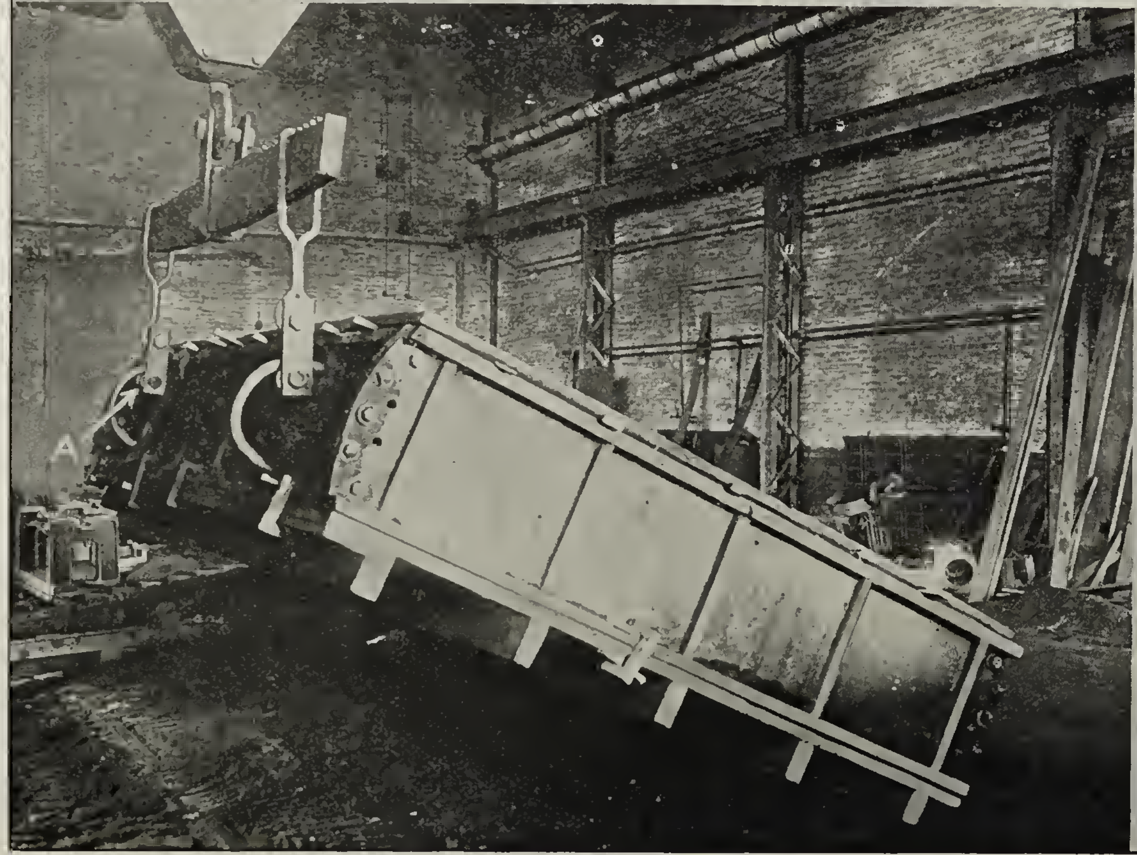
The historical and economic aspects of the industry having been disposed of, the remainder of the book is devoted to the more strictly technical discussion. Chapter heading such as Outline of Iron Metallurgy; Outline of Iron-Making Processes; Properties of Cast Iron; Classification of Castings; Foundry Raw Materials; The Technology of Combustion; Melting Processes; Mixture Making, and Testing Cast Iron, give one a pretty clear idea of the field covered.

In the chapter entitled, "Outline of Iron Metallurgy", we find brief sketches showing the relation of the element iron, and its compounds to the various divisions of the iron industry, together with a discussion of the general processes involved. In Chap. V the various iron-making processes are described as are also the various types of furnace in which the processess are carried on. The properties of cast iron are covered thoroughly, 80 pages being devoted to this subject. The book is the result of years of research work, both in the foundry and the laboratory. A complete and interesting discussion of each topic treated is the result.

The Buch Foundry Equipment Co., York, Pa., in a 4-page folder illustrates and describes its line of molding machines, including the gravity type and combination jar-ramming, roll-over squeezer and pattern-drawing machine. Molding machine accessories also are included, such as floor flasks and steel flask bars, machine pattern plates, jib cranes and trolleys, cast iron ladles, bottom plates, castings, etc.







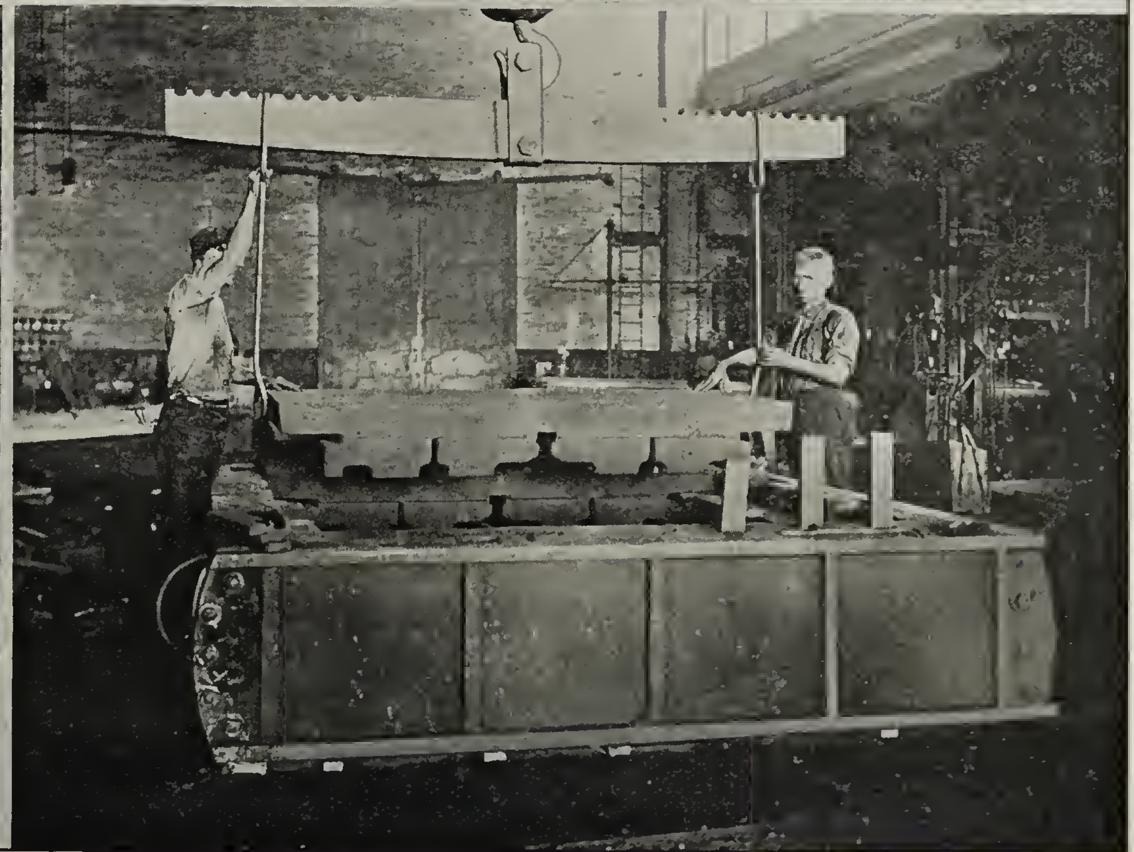


FIG. 1—FLOOR PLATE PATTERN BUILT UPON THE COVER CORE PRINTS
FIG. 3—HOW THE FLASK IS ROLLED OVER

FIG. 2—THE COVER CORE BOX IS SHOWN AT *A* AND THE ARBOR AT *B*
FIG. 4—SETTING THE COVER CORES

Casting Floor Plate and Bed For a Boring Mill

How a Large Molding Job Was Successfully Handled in Spite of Unusual Restrictions—Pattern Design Simplifies Coring and Molding

By William J Kihn

IN TIMES of industrial activity the average foundry always suffers from a lack of floor space, facilities for handling materials and equipment to handle heavy work. It is also heir to the many troubles of design of castings and insufficient and unskilled help that is the lot of all foundries, whether good or bad. Consequently, it is frequently forced to depart from strictly orthodox methods of molding to accommodate purely local conditions.

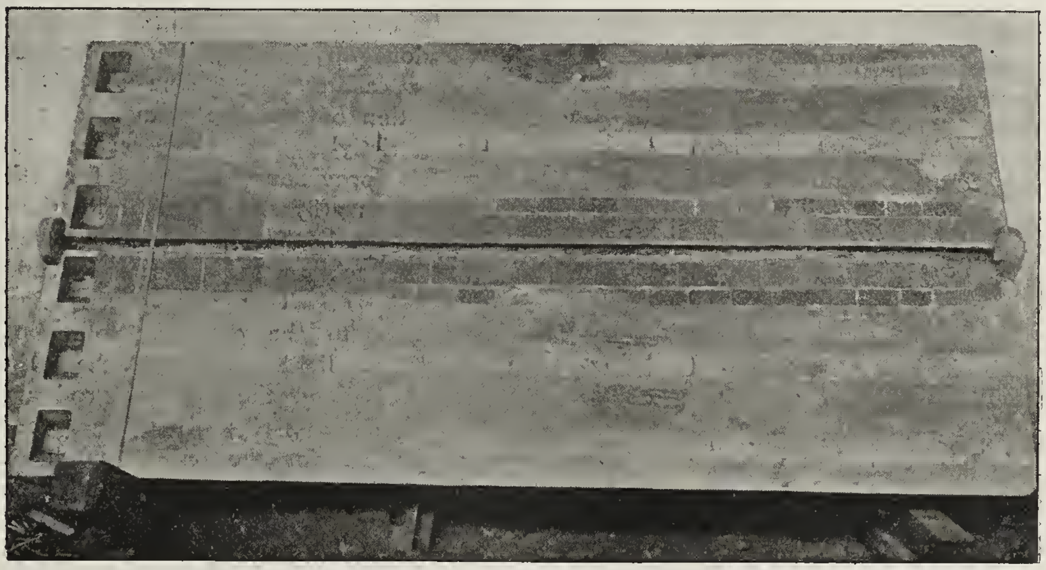


FIG. 6—FACE OF THE CASTING SHOWING THE CHILL IMPRESSIONS

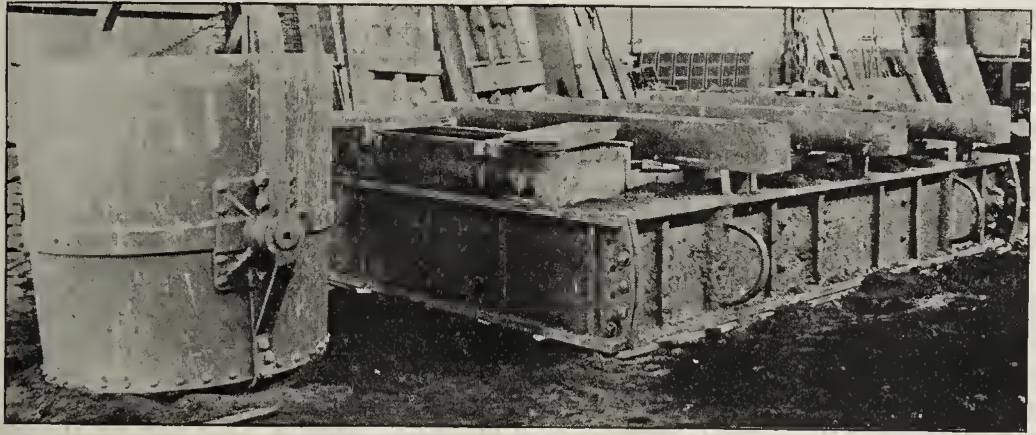


FIG. 5—THE FLOOR PLATE MOLD READY TO POUR

This being true at the foundry of the Gurney Electric Elevator Works, Honesdale, Pa., their molding practice and methods of surmounting some of their difficulties in the production of the floor plate and traverse bed for a line of horizontal boring mills might be of interest.

The floor plate is 6 feet wide and varies from 9 to 12 feet in length, according to the customer's desires. The 9-foot plate weighs 10,000 pounds and the 12-foot plate, 12,500 pounds. The traverse bed is made in lengths of 10, 12 and 14 feet, weighing from 4000 to 6000 pounds.

The room necessary to roll the floor plate drag is about 15 per cent of the available molding space beneath the crane. Due to lack of room and the expensive additions necessary for mold drying ovens, all dry sand work must be skin-dried. This, together with the varying length of the castings, lack of room for ramming, rolling, drying and storing the large cope necessary for a job of this kind, led to the decision to dispense with a cope and use large cover cores.

Fig. 1 shows the pattern built upon the cover core prints, Fig. 2 is a view of the cover core box and arbor. This box makes 3-foot sections of core and as the length of the castings vary by multiples of 3 feet, any additional length of casting merely entails the lengthening of the drag and pattern, and setting additional cores.

The arbor is of simple construction and is rigid enough to last for a long time. Cores may be stocked ahead, thereby lessening the chance of loss of production through injury to any particular cores.

The actual molding af the job is relatively simple. The pattern in Fig. 1 is placed upon the heavy board, shown clamped to the drag in Fig. 3, and is carefully leveled. Chills, some of which are in position on the pattern in Fig. 1, are placed along the line of location of the T-slots desired

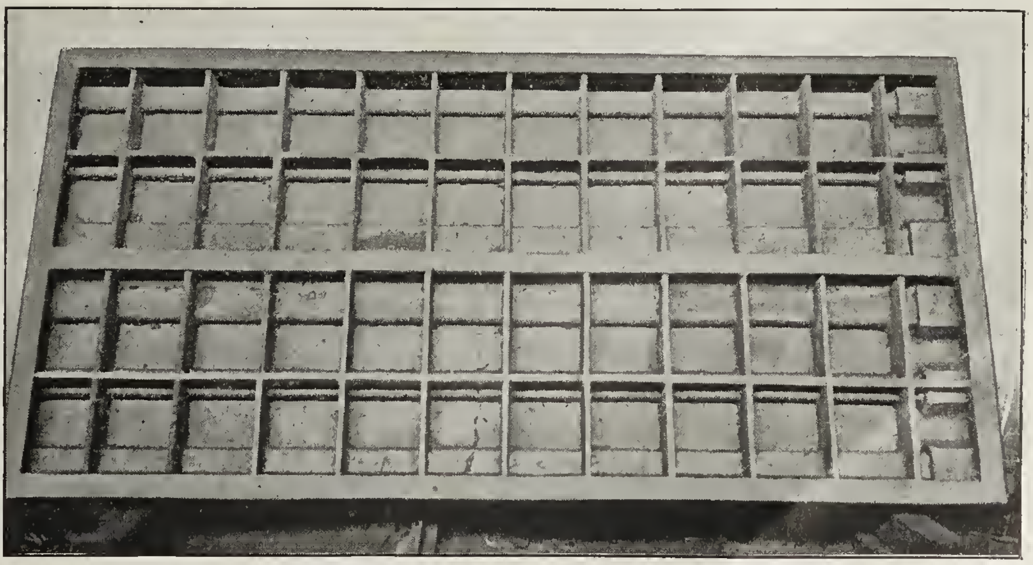


FIG. 7—REVERSE SIDE OF FLOOR PLATE CASTING, SHOWING THE CROSS RIBBING

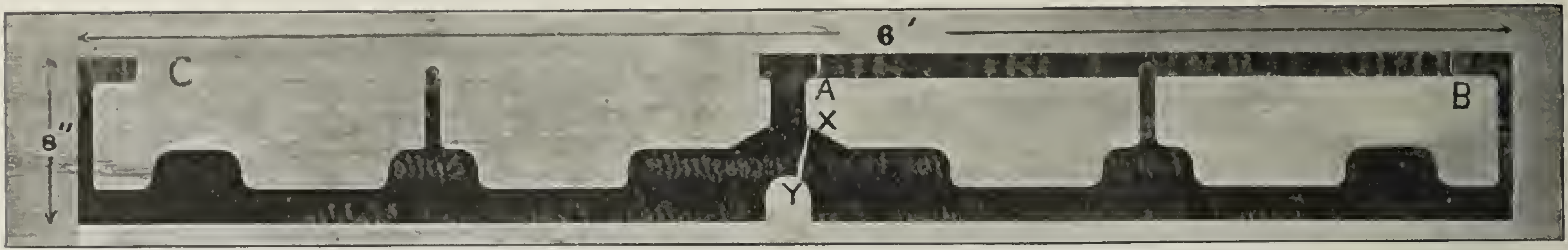


FIG. 8—PATTERNMAKER'S SECTIONAL LAYOUT OF FLOOR PLATE SHOWING UNEQUAL DISTRIBUTION OF THE METAL

in the finished casting. After ramming and bolting on the two cast iron bottom plates, the flask is ready to roll. Rolling by the usual method of hitching chains around the wrought iron eyes, however, was found to be impractical, as the slipping, and straightening-out of kinks in the chains, caused impact loads on the crane, which were above its safe working capacity.

A set of rolling slings, therefore, was devised by Thomas Fox, the foundry foreman. Each sling is composed of a grooved wheel, *A*, Fig. 3, yoked by two steel plates to a 1½-inch wrought iron sling. The slings are placed over a beam and by loosening the burrs, one of the yoke plates is dropped and the wheel is placed inside the eye. The plate is then replaced and power is applied. Since the grooved wheel rolls along the inside of the eye and as the point of concentration of the load and the center of the crane hook always lie in the same straight line, there is no appreciable friction or sudden jars to cause impact loads with consequent danger to equipment and human life.

After rolling, the pattern is drawn and the mold is finished. It is then dried over night with charcoal. The following morning the cover cores are set as shown in Fig. 4. These cores are secured by wedging them between pieces of channel iron which are laid on top of the cores and the binders which are bolted to the flask, in the manner indicated in Fig. 5.

The plate is poured from one end through six draw gates. These gates are each 3 x ⅝ inches in cross-section, the large total area of the gates being necessary in order to force the metal over the total length of the mold, the bottom of which is heavily chilled. The large amount of chills used to insure close-grained metal where the T-slots are machined and to equalize the cooling strains, is apparent from the face of the 12-foot casting, shown in Fig. 6. The illustration of the patternmaker's sectional layout, Fig. 8, indicates the tremendous variation in different sections of this casting. The line *AB* is a continuation of the inner flange, *C*, and is not strictly a part of the section. In spite of provisions to care for the strains set up by the improper distribution of metal, the first casting developed a crack at the gate end along the line *XY*. This was due, in all probability, to the quicker cooling of part of the light end walls, the light inner flange and the stresses produced by the light cross ribs which are spaced 1 foot apart for the entire length of the bed. These ribs are shown in Fig. 7, which is a view of the casting just after digging out the core. To alleviate these conditions, more chills were added along each side of the slot in the center of the casting; a curved chill, the location of which is shown on the pattern in Fig. 1, was placed in such a manner as to hasten the cooling of the metal at the point of rupture in order to strengthen it to resist the cooling stresses and, in addition, a heavy clamp was cast across the slot. This clamp is shown lying over the slot core print on each end of the pattern in Fig. 1 and has not been cut off in the illustration of the face of the casting in Fig. 6. These measures effectively stopped all cracking and marked the end of troubles with this casting.

Making the Traverse Bed

The traverse bed is another casting in which the metal distribution is very unequal, as shown by the section, Fig. 12. The variation and distribution of metal make it necessary to allow ⅜-inch rise to the center of the pattern as it lies on the board in Fig. 9. Since the pattern was built straight, two ⅜-inch pads, *A* and *B*, are placed on each end of the board on the joint line and the center of the board is clamped to the joint of the flask, and as the pattern is screwed to the board, a uniform curve is produced.

This job originally was molded with a number of cores, one lying between each set of ribs, which were spaced on one-foot centers. This involved setting 10 cores for a 10-foot bed, with spacing sticks, ramming a cope and securing them to it. The total time necessary to do this in the shop previously making these castings, was 26 hours. By combining and adding 4 inches of a cover core print to these cores, the number of cores were cut down to four, with a reduction in crane handling in the core room and foundry. Chaplets were eliminated and the molding time was cut down to 14 hours for one molder and a helper. The core time was not materially increased, the only added cost being the arbor and core material. This was a very small item compared with the saving in molding labor, however. It also permitted one casting to be made each heat, without duplicating rigging. The method of coring-up is shown in Fig. 10 and the ease with which it is done is apparent. The casting is poured from one end with four draw gates. The metal runs over a heavily chilled bottom the same as in the floor plate. The marks of the chills are clearly seen in Fig. 11, which is a view of the casting after cleaning. One point of interest is the decrease in hardness of the bed from the gate to the opposite end. Careful tests with a scleroscope indicate an average decrease of two points in the scleroscope reading. This apparently bears out the results of the investigations of the late Thos. D. West, who stated

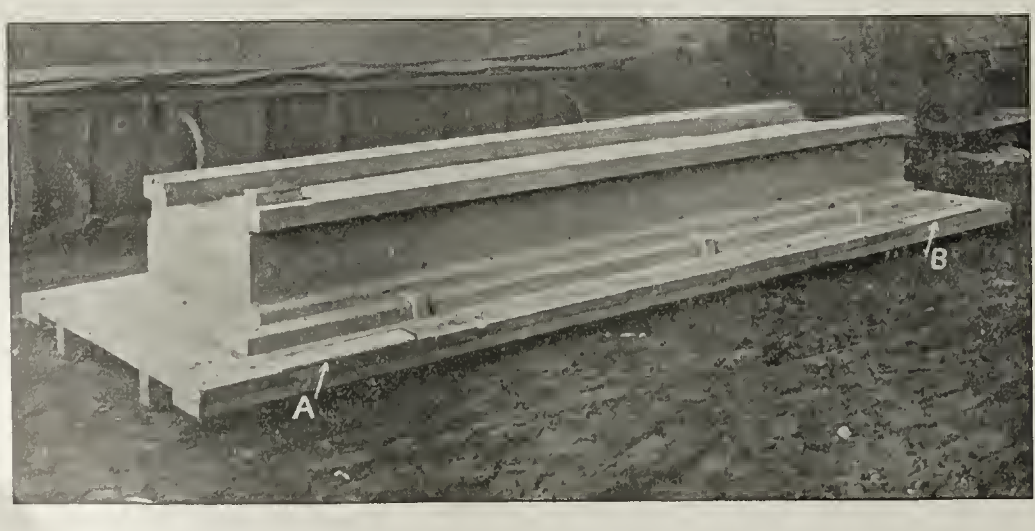


FIG. 9—TRAVERSE BED PATTERN ON BOARD WITH PADS *A* AND *B* WHICH GIVE RISE TO THE PATTERN

that the hotter the metal the greater the effect of a chill. The iron which solidifies at the gate being relatively very hot as compared with that which travels the full length of the casting over chills, is harder than the iron extending to the opposite end of the casting.

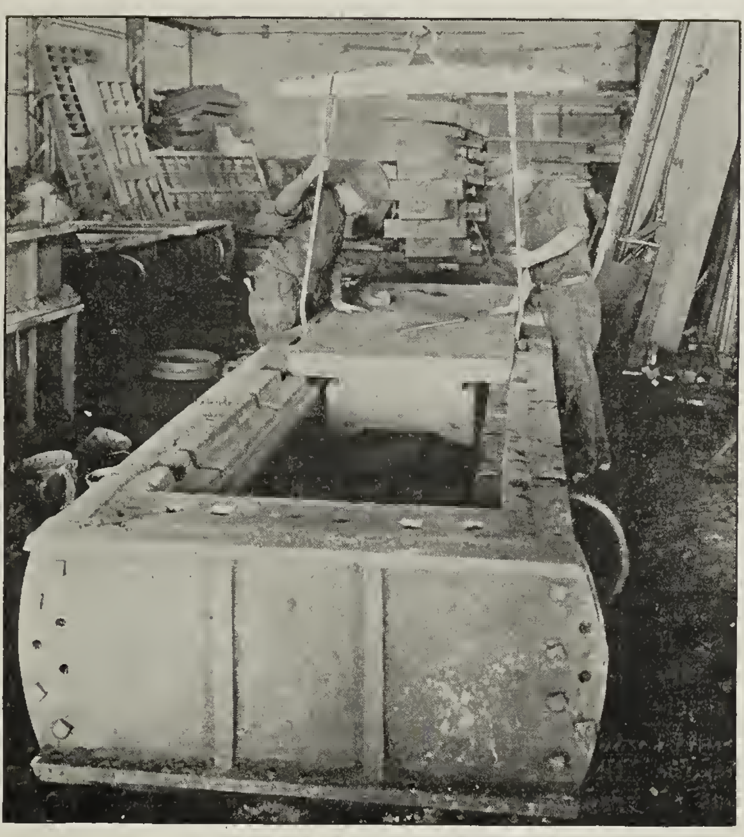


FIG. 10—CORING-UP THE TRAVERSE BED MOLD

Personals

Charles Davis has been appointed foreman of the foundry operated by the Utah Copper Co., Garfield, Utah.

John F. Schuster has been appointed manager of the foundry operated by the Locomotive Finished Materials Co., Atchison, Kans.

P. J. Kroll has resigned as representative for the International Oxygen Co., New York, in the Pittsburgh and central western territory.

The Asbestos Protected Metal Co., Pittsburgh, has appointed O. K. Olsen of New Orleans, sales agent for Louisiana and the southern part of Mississippi.

Max E. Biefeld has been elected secretary and treasurer of the Otto Biefeld Co., manufacturer of boilers, structural iron, machinery and castings, Watertown, Wis., to fill the vacancy caused by the death of Richard Biefeld.

Fred Maple has resigned as foundry foreman of the Bettendorf Co., Bettendorf, Ia. The foundry employes presented him with a watch and a purse and tendered him a banquet at the Rock Island club, Rock Island, Ill., at which J. F. Webb acted as toastmaster. Mr. Maple has been affiliated with the Chicago Malleable Co., Chicago; the Parlin & Orendorf Co., Canton, Ill.; the Western Foundry Co., Chicago, and the Davenport Locomotive Works, Davenport, Ia.

Fred L. Wolf, who was chosen secretary and treasurer of the American Institute of Metals at the annual convention of the institute held at Boston, Sept. 24 to 27, has been associated with the Ohio Brass Co., Mansfield, O., for several years. Mr. Wolf entered the engineering department of that company in 1911 as a chemical engineer. He progressed rapidly and in 1917 was named engineer in charge of manufacturing, the position which he now holds. Mr. Wolf was born at Elmore, O., May 12, 1885. In 1892 he went to Toledo, O., when the family removed to that city. Upon his graduation from Toledo high school in 1904, he entered the University of Michigan, graduating from there in 1908 with the degree of bachelor of science in chemical engineering. From 1909 to 1910 he worked as a chemist in the plant of the Detroit White Lead Works, Detroit, resigning to accept a position as a chemical engineer at Cobalt, Ont. He terminated his duties at Cobalt in 1911 to join the engineering staff of the Ohio Brass Co. Mr. Wolf holds membership in the American Chemical society and the Alchemist society of the University of Michigan.

A recently patented bearing alloy contains copper, 4 parts; antimony, 2 parts; nickel, 1 part, and lead, 1 part. This alloy, it is claimed, requires little lubrication.

Cadmium causes an explosion when added to molten copper and the addition should be made in very small pieces. Dense, brown fumes are given off from the copper up to the point of complete solidification.

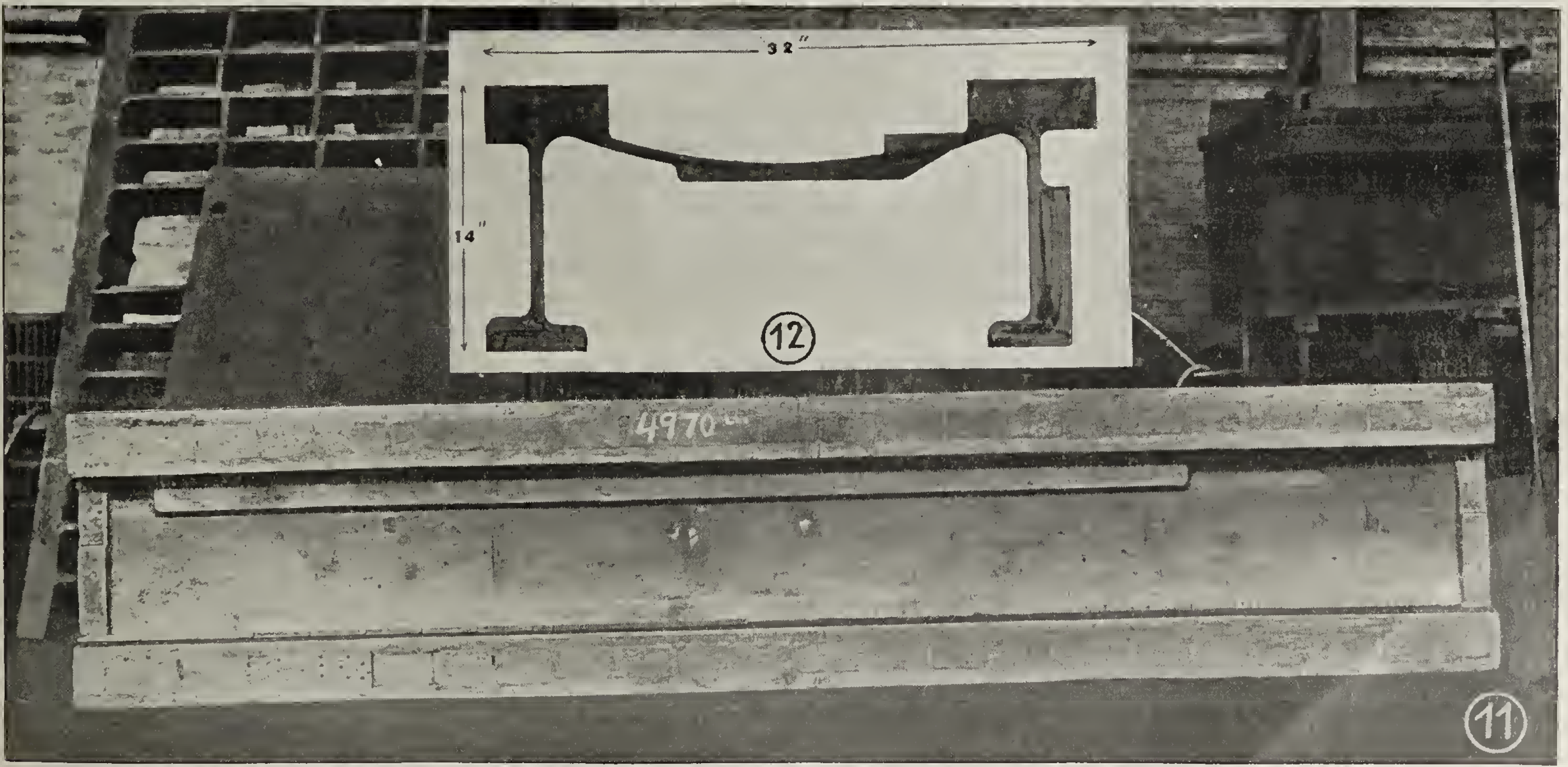


FIG. 11—THE TRAVERSE BED AFTER CLEANING, SHOWING THE MARKS OF THE CHILL. THE INSERT, FIG. 12, IS A CROSS-SECTION OF THE CASTING, SHOWING THE UNEQUAL DISTRIBUTION OF THE METAL

How the War Affects Manufacture of Crucibles

Imports of Plumbago and German Clay Cut Off Early in War —Experiments With Substitute Materials for Crucibles Proceed Slowly

By M McNaughton

LIKE many other industries, the manufacture of plumbago crucibles has been affected by conditions arising out of the war. The disturbances set up have extended to the users of crucibles, affecting them seriously in the way of increased costs and in some cases, reducing output because of a shortage of supply. It has been suggested that it would be well if the crucible user were more fully informed as to those details of crucible manufacture which have been most disturbed by war conditions, referring of course to the conditions of supply and demand of the essential materials of crucible making. The important and essential ingredients of the plumbago crucible are the plumbago, and the clay which serves to hold the crucible together in the process of manufacture and in use.

Before the war all of the clay for crucible purposes was imported and probably 95 per cent of the plumbago. The clay used almost exclusively came from the small town of Klingenberg in the western part of Germany. The mines are the property of the town and the profits from the operation of the mines largely meet the municipal expenditures. The clay is of remarkable quality and uniformity, and the extent of the deposit has made it an adequate supply against the large demands made upon it. These facts have made this clay by far the best yet known for the crucible maker's use. Clay was mined and shipped during the entire year, shipments reaching this side in from four to six weeks after leaving the mines. But, even with these favorable conditions, the maker usually carried a year's supply on hand to secure the advantage of natural drying, the clay carrying about 20 per cent free water, and to minimize and have time to detect and correct slight variations occurring from time to time in its quality.

Clay Shipments Stopped

Shortly after the war began, Germany prohibited the shipment of this clay, perhaps foreseeing the large demand of the allies for ammunition and metals from this country. The rapidly increasing demand for crucibles shortly after the beginning of the war indicated that a supply of clay usually sufficient to last a year would supply the needs of the manufacturers only a short time and that a substitute must be found. The crucible industry found itself in the same position as that of many others, which for years had relied on what had appeared to be an absolutely dependable supply, both as to quantity and quality.

So it happened that very quickly the manufacturer was launched on the sea of experiment at a time of rapidly increasing demand, which increased finally to such a point where users waived all claim for quality, provided quantity was sufficient.

Appreciating the difficulties ahead, the crucible maker warned his customers what might be expected by informing them that the quality of crucibles made from domestic clays was an unknown quantity and that crucibles would be sold only on that understanding.

As anyone familiar with their manufacture knows, the actual testing out of refractories is a very slow and long drawn-out process. In the case of china ware, the testing would be largely in the way of overcoming the difficulties of manufacture. In the case of crucibles these difficulties are not serious, but the real test it has to stand is that of actual service.

No Substitute for German Clay

The chemical and physical laboratory has been called upon, in the search for a suitable substitute for the German clay, but the results of such investigation have for the most part been negative, that is, by such investigation we are enabled only to eliminate from real test such materials as do not measure up to such standards as have come to be recognized.

Many score of clays have been examined and perhaps a score have given indications of possible successful use. A clay giving favorable indications is mixed in varying proportions with the other ingredients of the crucible, among which may be other clays (for at the present time a blended clay seems to be the solution) and trial lots are made, say six, of each mixture. Owing to the long time required to make and burn crucibles and adding to the time required for transportation and actual use, two months is the shortest period required to get results from such tests and it is more likely to be three.

If the result of such a trial is favorable, another lot is made up, this time of 50 or 100 pots and sent out to different users. If the results obtained by the different users are in practical agreement the information is of real value. But when the reports are not in agreement, as is often the case, the test must of course be repeated.

Test Results Unsatisfactory

In this connection it may be mentioned that one of the difficulties the crucible maker labors under is in getting informing reports as to the running of test lots of pots. This was particularly so during the period just passed. Many users did not appreciate the seriousness of the situation, and how important it was to the maker to get this information in a very accurate way. Later on as the rush of business increased, it of course became more and more difficult to keep accurate records, and undoubtedly the employment of many green workmen added to the uncertainty of the results obtained.

In order to obtain results as quickly as possible, many experiments have to be carried on simultaneously. Under such circumstances, a long time must elapse before information becomes available, but as the information accumulates there is steady progress toward the desired end. The results secured by the early attempts to use domestic clays were unsatisfactory. In certain cases the average heats secured were four or five as against 25 to 30 previous to the war. At the present time results are much better, from 15 up to 20 and 25 heats being the range of average service. These figures refer to an average size crucible, say No. 80, used in standard rolling mill practice.

The process of elimination has narrowed down the clays now in use to a comparatively small number, and concentration in the study and use of these must result in the steady, though perhaps slow, improvement in the quality of the crucibles made from them. It is not to be assumed that the testing of other clays is to

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Presented at the Boston meeting of the American Institute of Metals.

THE FOUNDRY DATA SHEET, NOVEMBER, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

FORMULAS FOR THE BRASS FOUNDRYMAN

Proprietary Bearing Alloys

The following bronzes are used extensively as bearing alloys, and while the names by which they were known when first produced have generally been discontinued, occasionally one of these alloys is specified by its original name. The list of alloys presented herewith permits of the easy identification of any of these alloys:

"S" Bearing Metal

	Per Cent
Copper	79.70
Tin	10.00
Lead	9.5
Phosphorus	0.80

"S" bearing metal also is used as an acid-resisting alloy. The amount of phosphorus can be varied to best meet the requirements of individual cases. The difficulties of making castings are increased in proportion to the increase of phosphorus. When the phosphorus is eliminated, the alloy becomes a straight 80 copper, 10 tin and 10 lead mixture.

Ex. B. Metal, Pennsylvania Railroad

	Per Cent
Copper	76.80
Tin	8.00
Lead	15.00
Phosphorus	0.20

"Ex. B. Metal" is used for car journal bearings and also sometimes for anti-acid purposes.

Ajax Plastic Bronze

	Per Cent
Copper	65
Tin	5
Lead	30

Ajax plastic bronze also is used extensively for car journal bearings and occasionally is used as an acid-resisting alloy.

The Foundry, Data Sheet No. 245, November, 1917.

FORMULAS FOR THE BRASS FOUNDRYMAN

Proprietary Bearing Alloys

Ajax Metal

	Per Cent
Copper	77.00
Tin	11.50
Lead	11.50

A small amount of phosphorus may be added to Ajax metal to reduce oxides formed in melting. About 0.25 per cent of 15 per cent phosphor copper is sufficient for this purpose.

Carmelia Metal

	Per Cent
Copper	70.00
Tin	4.50
Lead	15.00
Zinc	10.00
Iron	0.50

Carmelia metal is a complex alloy. The advantages of the iron addition are rather doubtful.

Carbon Bronze

	Per Cent
Copper	75.00
Tin	10.00
Lead	14.50
Carbon	trace

Cornish Bronze

	Per Cent
Copper	77.80
Tin	9.50
Lead	12.50
Phosphorus	0.20

Damascus Bronze

	Per Cent
Copper	76.90
Tin	10.50
Lead	12.50
Phosphorus	0.10

The Foundry, Data Sheet No. 246, November, 1917.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

be stopped. This work will go on until the best clay or clays for the purpose has been discovered.

As some users know, there have been lapses in the forward progress of the quality of the crucibles during this period of change. Such variations are in part explained by the fact that the clay miners in the earlier period were not prepared to meet the demands made upon them, and in later periods to the fact that railway transportation fell down for weeks at a time, during which periods shipments could only be made by express and of course at enormous expense. Furthermore, these clay mining operations are mostly open workings, and subject to weather conditions and unproductive on this account for days and weeks at a time. The clay operators having prospered have so increased their equipment that a sufficient production is now reasonably assured, and with the government in a position to control shipments, transportation troubles should not recur.

The supply of plumbago for crucible making comes mostly from the Island of Ceylon, not more than 10 per cent coming from Madagascar and America. The Ceylon plumbago differs from the other kinds by being more cubical in its crystalline structure, while the Madagascar and American graphite is in the form of thin flat flakes. The stock of Ceylon plumbago usually carried is a two to four months' supply, with a similar amount contracted for. Shipments come usually by direct steamer and require from five to eight weeks. The supply is usually regular, but may be interrupted by reason of extremely wet seasons, quarantine restrictions and perils of the sea. At the war's commencement, stocks in the makers' hands were probably larger than usual on account of bad business conditions prevailing in this country at that time.

For the information of those who have thought that the use of domestic clay should have a lowering effect on the cost of crucibles, it is sufficient to say that its cost is now more than double that of the German clay previous to the war.

In October, 1914, the British government placed an embargo on plumbago exports from Ceylon, which lasted more than four months. As a result of this interruption stocks here were entirely cleaned out.

In the meantime the demand for crucibles was growing and the insistent demand for shipments of plumbago on old orders, as well as the increase in quantity on new orders, started an upward movement in prices which never stopped until they were more than three times what they were before the war began.

After the embargo was raised shipments came forward with sufficient regularity to generally meet the requirements, although all of the makers would at times be out of material for short periods.

Raw Material Supply Improves

The conditions as to the supply of both of these materials, clay and plumbago, are much more satisfactory than they were a year ago. Supplies are calculated on a much larger output of crucibles, nearly all of the makers having increased their production. The annoying shortage which prevailed during 1916 will not occur again as a result of insufficient works capacity. Crucibles are of much better quality on an average than during that period so that the same number of crucibles will melt a much greater quantity of metal. The quality of the crucibles will be improved still further as more and more knowledge of the domestic clay is acquired.

The crucible maker expects to be able to meet any emergency that may come, and to do it in a way far more satisfactory to the crucible user than has been the case during the past two years.

Suggestions For Melting Brass

IN AN address at a meeting of the London branch of the British Foundrymen's Association recently, H. G. Barrett stated that the demands of engineers in the past for bronze and brass castings in most instances have been prompted more by a name than by a knowledge of the properties of the alloys required. There is no reason, Mr. Barrett contended, why this practice should prevail at present, as nonferrous alloys to fullfil special requirements have been made available by extensive research and there is now at the disposal of foundrymen, information as to the physical properties of alloys in a convenient form for immediate use.

Metals and alloys of guaranteed analysis can be purchased and many foundrymen are now using ingot metals instead of alloying the metals in their own foundries. In the selection of copper ingots, it should be noted that underpoled ingots are distinguished by a longitudinal furrow on the upper surface; overpoled ingots by a longitudinal ridge, while good, tough, copper ingots should have neither ridge or furrow, and except for a slight depression of the surface, due to contraction, the upper surface should be comparatively smooth. Underpoled copper and overpoled copper have a blue tint on the surface of the ingot on each side of the ridge or furrow, and good copper has a red, silky appearance in fracture.

How to Test Tin

The purity of tin can be ascertained by a rough test. If the tin is melted, and then when near the freezing point, it is poured into a small ingot, and the surface remains bright, the tin is pure, but if it assumes a dull, frosted appearance, it contains impurities. This appearance becomes very marked when lead is present. The crackling sound heard when tin is bent is also a rough indication of its purity.

Scrap is one of the most perplexing materials the brass founder has to contend with, and in spite of the economic advantage obtained by its use, it requires much judgment in sorting, and in proportioning additions of zinc, tin and lead to obtain successful results.

The composition and character of an alloy cannot always be determined by its color. It is possible to make a high zinc brass that will resemble gun metal when machined. Aluminum bronze also is difficult to identify, and there are many other metals that also add complications to the use of scrap when run down in crucibles. The safest way to use scrap to obtain uniform castings is to melt it in an air furnace, run it into ingots, obtain an analysis and so learn the deficiency of tin and spelter. When the ingots are remelted for use the necessary additions of white metals can be made to bring the alloy to the composition desired.

A convenient size of air furnace is one holding around 3000 pounds of metal. The main points in operating such a furnace are uniformity in firing so as to raise the temperature quickly, and keep it constant, and to create a reducing atmosphere that will protect the metal from oxidation. In starting the furnace, only a few hundred pounds of metal should be charged at first, so as to form a bath in the well of the furnace. This bath is quickly brought to a temperature that will enable it to dissolve additional metal. After an addition, the bath should be allowed to regain its heat, to dissolve more solid metal, and this process is continued until all the metal comprising the heat is melted.

When firing the furnace, the damper should at first be lowered to prevent cool air from passing through the furnace. The coal or coke should be spread evenly over the whole surface of the fire and not banked in spots, as this causes variations in temperature. The addition of too much fuel at a time chills the furnace. This is indicated by the production of a large amount of smoke. The clinkers can be easily removed by inserting a flat bar between the fire bars from underneath, providing a fulcrum for the bar to rest upon, so it will form a lever when the end extending from the furnace is depressed. This action forces the other end up between the bars and dislodges the clinkers, which are then removed through the furnace door by the aid of a rake. This should be done immediately before firing. The damper should also be lowered before the furnace is charged, and the surface of the metal must be kept covered with charcoal.

Pieces of hard wood and old bags filled with sawdust can be thrown onto the metal and will assist in economizing charcoal. When the metal is ready to be tapped from the furnace, a little phosphor-copper should be added to assist in reducing the oxides.

Removing Defects in Metal

The melting operation may produce many defects in the metal due to the inclusion of oxides or dross, and it is not easy to remove them once they get into the alloy. Remelting will remove gas holes produced by defects in molding, but will not remove those produced by oxidation. For this latter defect, deoxidizers must be used, but they are not all successful, as in removing the oxides, gases which increase the porosity may be generated.

A satisfactory method of cleaning the metal is to place a little plaster of paris in the bottom of the crucible before charging. After the metal is poured into the crucible, stir to dislodge the plaster, causing it to rise through the metal and carry the entangled oxides with it.

The iron taken up by the metal from the stirring rod does no harm, as iron-bronze consisting of 5 per cent iron, 10 per cent tin and 85 per cent copper, was used in Europe as far back as 1850. Some metal has also been discovered that contained as much as 10 per cent iron, as well as 10 per cent tin. It was used for making field guns.

Salt is a valuable flux, but objectionable on account of its irritating fumes. Its value is due to its readily combining with sulphur, thus forming a continual protection to the metal during the melting period. Chloride of lead is useful when the scrap is very dirty, and should be used in conjunction with plaster of paris as described. When the crucible is taken from the furnace and has been stirred, the chloride of lead should be added by enclosing it in a piece of paper tied to the end of a rod, which should be plunged quickly to the bottom of the crucible.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Aluminum Casting Difficulties

We are experiencing difficulty in the manufacture of small aluminum castings due to the fact that the metal will not lie on the sand in the bottom of the mold unless the sand is warmed. Can you recommend a better method of casting aluminum? The mixture consists of all scrap aluminum. What is the best sand to use for these castings?

The aluminum will lie on the bottom of the mold provided the latter is rammed soft and the metal is poured cool. The thickness of the casting should determine the temperature at which the metal is to be poured since a thin section will probably have to be poured with the metal at red heat. However, if this temperature can be avoided without causing misruns, better castings will be obtained. The sand at the bottom of the mold should be rammed soft, but not soft enough to produce swells and the molds should be vented with fine wire over the spots where the metal fails to lie quiet.

You will always experience the danger of a high zinc content when using scrap aluminum and this also may cause the difficulty outlined. The remedy is to use new aluminum with the scrap and to reduce the zinc content to a point where it is less difficult to obtain good castings. Therefore, some study will be necessary to determine exactly where the difficulty lies, and after the cause has been ascertained, the remedies suggested may be applied.

Segregation of Lead

We have an order for a number of castings to be made from the following mixture: Copper, 66 per cent; tin, 6 per cent; lead, 27 per cent, and phosphor-tin, 1 per cent. The metals in this alloy do not mix thoroughly, however, and any suggestions that you can make that will help us to overcome this difficulty will be appreciated.

No trouble should be experienced in making this alloy, since a mixture containing 30 per cent lead, 5 per cent tin and 65 per cent copper is in daily use and ingots of this composition may be purchased from the manufacturers of metal ingots. We suggest that the prosphor-tin be omitted, as this undoubtedly has a tendency to throw the lead out of solution. Adding 1 per cent nickel is advisable.

Melting Brass in the Cupola

We expect to make a large brass casting, 54 inches in diameter, 17 inches in depth, 1¾ inches thick and weighing 1700 pounds. The metal must be close-grained since the casting is to be cut into rings, ¼ inch thick. What mixture do you recommended and how should we proceed to melt the brass in a 32-inch cupola?

A comparatively coarse sand with a large proportion of new sand should be used for making the mold and the casting should be gated at the bottom, using dry sand runner cores if a three-part flask is not employed. Two runners should be provided, located opposite each other across the circumference of the ring and four 3-inch risers should be placed on the cope equally distributed around the circumference. These should be gated to the outside of the ring with heavy gates to provide a sufficient amount of the metal to enable the risers to feed the ring.

Heavy red brass scrap is suitable for cupola melting and after the metal has been charged on the coke, add a small amount of salt before making a further charge of coke. The metal should be melted very hot and a layer of burning charcoal should be placed in the bottom of the ladle onto which the metal is tapped. If red brass scrap is not available, use the following mixtures: Copper, 85 per cent; tin, 5 per cent; lead, 5 per cent, and zinc, 5 per cent. If possible, run this mixture into ingots and re-melt them in the cupola. The ingot metal should be melted in a brass furnace.

Metal From Brass Concentrates

We have a large quantity of brass concentrates which we desire to remelt into ingots. The concentrates are finely divided and contain copper, 83 per cent; tin, 2 per cent; zinc, 5 per cent, and lead, 10 per cent. How would you suggest treating this product to recover the maximum amount of zinc and copper?

If the concentrates carry considerable dirt, such as carbonaceous, silicious or iron matter, they should be melted in a water-jacketed cupola and plenty of limestone should be added to produce a slag having the consistency of cream. Less than 1 per cent of the copper should be carried into the slag, but it is probable that 50 per cent of the zinc will be lost. If the fineness of the concentrates causes trouble, they should be briquetted, which can be accomplished by mixing them with plaster of paris, or stucco and forming the mass into bricks. The plaster of paris will serve as a flux, emitting part of its oxygen and part of its sulphur. The iron present will combine with the oxygen to form ferrous oxide and the copper will absorb the sulphur. The ferrous oxide will combine with the sulphur and go to the slag, and the copper sulphide will react with any oxide and form metallic copper and sulphur dioxide. Therefore, the plaster of paris will do no harm. If the concentrates are melted in an open-flame furnace with fuel oil, it would be advisable to add new metals to change the composition of the ingots to some standard alloy containing less lead to prevent hard spots appearing in the castings made therefrom.

Aluminum Mixture For Pistons

We would like to obtain an aluminum mixture suitable for automobile pistons.

Mixtures of aluminum alloys suitable for the purpose mentioned were published on Data Sheet No. 235 in the June, 1917, issue of THE FOUNDRY. This formula is for a strong aluminum alloy and directions are included for making it. If this mixture is too difficult to produce, or is unsuitable for other reasons, other alloys will be found on Data Sheets Nos. 241 and 242 in the September issue of THE FOUNDRY.

Bronze to Resist Mine Water

We would like to have a bronze mixture that will satisfactorily resist the corrosive action of mine water containing a high percentage of sulphuric acid and sulphate of iron.

The resistance of a bronze casting to the acid of mine water is in proportion to its freedom from oxides rather than being attributed to its composition; from this it may be inferred that the composition of a bronze is secondary to its quality when required to resist the corrosive action of mine water. An alloy consisting of copper, 90 per cent and tin, 10 per cent, which may be cast easily, will resist the action of mine water as well as anything that may be employed. However, the castings must be sound, dense and free from oxides of copper and tin. If a strong metal is desired, we recommend the use of this alloy, but we desire to emphasize the necessity of protecting the copper, while melting, with some fusible flux, such as glass, in addition to the charcoal generally employed.

A cheaper alloy than the one given follows: Copper, 86 per cent; tin, 8 per cent; zinc, 5 per cent, and lead, 1 per cent.

In some instances the high-leaded alloys can be used to advantage.

The following mixture may be employed where the strength desired of the casting will permit its use: Copper, 78 per cent; tin, 7 per cent, and lead, 15 per cent. However, any of the alloys given will be satisfactory.

What is Aluminum Nitride?

We were very much interested in the article on the conservation of metals published on page 209 of the June issue of THE FOUNDRY, *especially the mention of aluminum nitride, but as we cannot find any reference to this substance we assume that it should have been nitrate or nitrite instead of nitride. Also, would a furnace that is arranged so that the hot air is kept away from the metals in melting, be serviceable in melting aluminum or brass, and would some of its value be due to the melting without the use of fluxes which may possibly be injurious to the metal?*

The word nitride in this article is used correctly. A nitrate is a salt of nitric acid, such as sodium nitrite ($NaNO_3$). A nitrite is a salt of nitrous acid, such as sodium nitrite ($NaNO_2$). Aluminum nitride is formed in electric furnaces from aluminum oxide by the Serpek process, according to the following reaction: $Al_2O_3 + 3C + N_2 = 2AlN + 3CO$. The reaction is strongly endothermic, absorbing, according to Richards, 213,220 calories.

Aluminum nitrate is formed by dissolving aluminum in nitric acid, or by dissolving the hydroxide in the same acid. Its formula is $AL(NO_3)_3 9 H_2O$. The formula of aluminum nitride is ALN. The two substances are entirely different.

A furnace which does not bring in contact the products of combustion in melting is desirable. Fluxes, however, rarely harm the molten metals as they are generally too stable chemically to be broken up by the metals melted in ordinary practice.

Anti-Acid Bronzes

We would like to have several anti-acid bronze mixtures. We desire to make these alloys from new metals and they should have a tensile strength ranging from 40,000 to 60,000 pounds per square inch.

An excellent alloy for anti-acid purposes consists of copper, 90 per cent and tin, 10 per cent. When carefully made, test bars cast in sand should develop a tensile strength of 40,000 pounds per square inch. The term *carefully made* implies exercising every possible precaution to prevent the oxidation of the metal during melting. If a tensile strength of 60,000 pounds is required, either manganese or aluminum bronze must be employed. To make manganese bronze it is customary first to mix a hardener as follows: Wrought iron, 18 pounds; 80 per cent ferromanganese, 4 pounds, and tin, 10 pounds. Melt the iron and manganese together, and when liquid, add the molten tin, stirring meanwhile. Pour the cast into water for the purpose of granulating it. For mixing the bronze use copper, 56 pounds; aluminum, 0.5 pound; zinc, 41.5 pounds and add 2 pounds of the hardener.

To produce aluminum bronze, melt 90 pounds of copper under charcoal and when liquid, add 10 pounds of pure aluminum; stir and cast into ingots.

Making Vanadium Bronze

We have received a government order for vanadium bronze castings weighing from 60 to 100 pounds. Kindly let us know how to make this mixture.

Vanadium bronze is a manganese bronze that has been treated with vanadium. The mixture is approximately as follows: Copper, 57 per cent; tin, 1 per cent; 1 per cent of 30 per cent manganese-copper; iron, 1.5 per cent; aluminum, 0.25 per cent; zinc, 39.25 per cent with a sufficient amount of vanadium to deoxidize the mixture. Any manganese bronze alloy that will meet the specifications as to chemical composition and physical properties can be used for this work and unless experienced in making manganese bronze, it is advisable to purchase the ingot metal from some of the manufacturers of this mixture.

The Role of Metallography in the Foundry

How the Microscope Can Be Used to Test and Control Product —Industry Now Awakening to Importance of Metallography

By Robert J Anderson

THE object of this contribution is to call attention to the possibilities for important advances in the application of the metallographic microscope as a means of testing and controlling the products of our foundries. As is usually the case with all important developments, skepticism has prevailed, and mistakes have been made; it even may not be overdrawing the history of metallography to remark that the most absurd predictions have been advanced as to what the microscope could accomplish. All this has done much to confound the metal industries. Many difficulties have had to be overcome, but as knowledge has progressed, and the number of applications have increased, the causes of trouble have gradually been eliminated. To set forth a complete treatise on the scope of metallography and its application to the iron and steel foundry business would be a task of considerable magnitude, mainly because of the large mass of material which has been published in the metallographic field, and secondarily because of the inherent difficulty of a logical presentation of the subject. Rapid strides have been witnessed in the past few years, so that at the present writing the methods of metallography find extensive application as a means of control in the metal industries and even in foreign fields. The knowledge we now have relative to the relation which grain size bears to the physical properties of metals and their alloys has given rise to a new method of scientific regulation.

Metallography's Rapid Advance

Thirty years ago, metallography as a science was virtually unknown, and it is only within the last 15 to 20 years that it has received serious consideration by manufacturers and consumers as a valuable means of metal testing. The development in the early years of its history was slow, but the advances in the past five years have probably exceeded all those previously made. At present metallography is taught in almost all technical and engineering institutions of university grade, and the methods of metallographic testing find wide use in iron and steel and in nonferrous metallurgy.

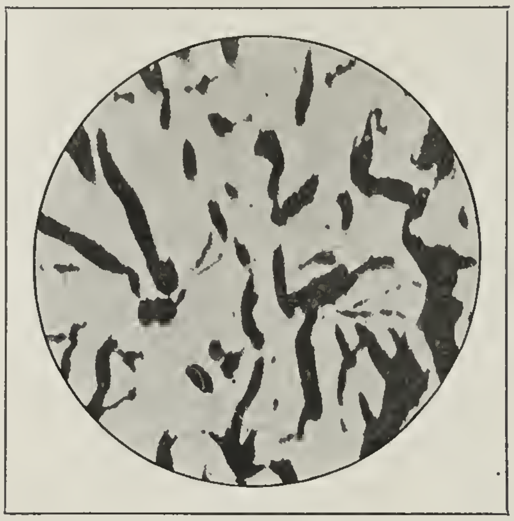

FIG. 1—GRAY CAST IRON, UNETCHED
(Magnified 100 Diameters)

Metals and alloys owe much of their industrial importance to their physical properties, and it is in the testing and determination of these physical properties that the methods of metallography have come to be indispensable. The physical properties of metallic alloys are dependent upon their structural compositions rather than upon their ultimate chemical compositions, and in revealing the former, metallography demonstrates its value. The chemical analysis furnishes information which is highly desirable, but it cannot make possible much knowledge concerning the structure and physical constitution of substances. It will be recalled by most people interested in iron and steel, that the chemical laboratory experienced difficulty in the early days in finding a place in the works; metallography has gone through the same trying stage in its short existence. That it has demonstrated its true worth is proved beyond doubt by the large number of manufacturing concerns that have installed laboratories and by the service it has rendered.

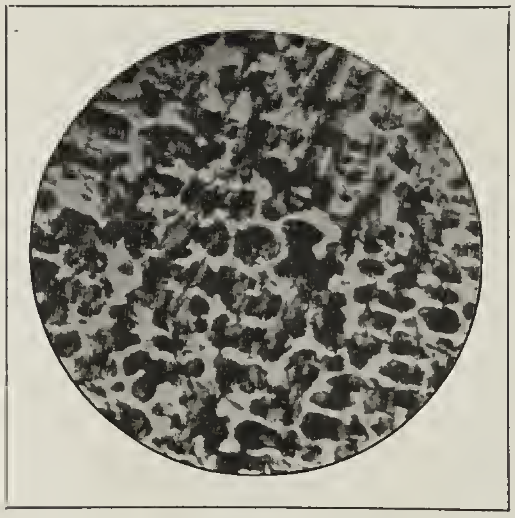

FIG. 2—WHITE CAST IRON, UNETCHED
(Magnified 100 Diameters)

Why Foundries Have Been Slow

It appears that the foundry interests have not taken to metallography with the interest which the science deserves, and there is unquestionably sufficient reason for this condition. In the first place, the foundry interests are, broadly speaking, considerably diversified, and their tonnage per unit is smaller than in the case of steel works, so that the installation of a laboratory and the employment of a metallurgist would not appear warranted from the standpoint of first cost. Secondly, it seems that in comparison to certain other industries fewer men highly trained in science have entered the foundry field. The reason for the latter condition is not exactly apparent because the opportunities are large. Only a small percentage of the foundries in this country employ metallographic methods, so that the field would appear to be practically virgin. Therefore, by deduction from what metallography has accomplished in other fields, the writer has every reason to believe that a consistent and intelligent application of this science will improve the product of the foundries in a measure out of all proportion to the amount of endeavor.

There is no attempt in this paper to explain the methods of metallography. As regards foundry applications, the subject has been dealt with at length by others. Several text books on the subject have appeared in the past few years, and we now have "Metallography", by Cecil H. Desch; "The Metallography and Heat Treatment of Iron and Steel", by Albert Sauveur, in which the practical aspect is well cared for; "The Metallography of Steel and Cast Iron", by H. M. Howe; "Metallic Alloys", by G. H. Gulliver; "Physical Metallurgy",

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Read at the 1917 annual convention of the American Foundrymen's association. The author is metallurgist, the Cleveland Metal Products Co., Cleveland.

by Walter Rosenhain, a lucid exposition; and "Metallographie", by W. M. Guertler. The *Journal* of the Iron and Steel Institute, London, devotes considerable space to the ferrous field; and the *Internationale Zeitchrift fur Metallographie* covers both ferrous and nonferrous metallography. Wm. Campbell recently summarized the late progress in metallography.

Metallography of Cast Iron

The available literature on the metallography of cast iron is indeed meager, so that it may not be out of place here to recall a small portion of the present knowledge. The paucity of literature is one criterion from which we may deduce that no great deal of scientific work has been accomplished, at least not in any measure comparable with what has been performed upon both carbon and alloy steels. It appears to be an idle ceremony to discuss in this place the phenomena which occur when alloys of varying carbon content pass from the liquid condition to room temperature. These phenomena are readily secured from a consideration of the now well-known carbon-iron diagram. It suffices to state that our knowledge of the transformations in steels and cast irons is based upon this diagram, as are all methods for heat treatment.

For a proper understanding of the structure of cast irons, or other metallic alloys, it is of prime importance to observe the macrostructure or structure as it appears to the naked eye. This is equivalent in practice to the examination of fractures of broken castings. Sudden breakages are indicated, in general, by a granular appearance, while fractures which have resulted from repeated stresses will be smoother. Macroscopic examination may show, in a failed part, at what point the fracture initiated, due to local defects. In the event that local defects are not found or in case microscopic examination is desirable, micro-sections should be secured. Macroscopic examination may readily distinguish between various types of irons by simple inspection of the fracture, but it is not to be relied upon as absolute.

Knowing the constitution and heat treatment of any given iron, we can predict with certainty what its structure will be. In general, the latter will be dependent upon the percentage of carbon present, upon the condition of the carbon, and therefore upon its chemical composition or heat treatment, or both. The carbon present in cast iron may be in three different forms: First, entirely in the combined forms, as cementite; second, entirely in the uncombined form, as graphite; and third, partly combined and partly uncombined. These three occurrences are considered in the following paragraphs, but first it may be well to consider the formation of combined and graphitic carbon. When cast iron freezes, the carbon remains in the combined form as Fe_3C, but this is an unstable compound, so that the reaction

$$Fe_3C = 3Fe + C$$

is always striving to occur. Two factors are particularly cogent ones in promoting the formation of graphite: First, slow cooling during and below the freezing range; and second, the presence of silicon. The conditions most favorable to the production of combined carbon are: First, rapid cooling during and below the freezing range; and second, high manganese or sulphur content.

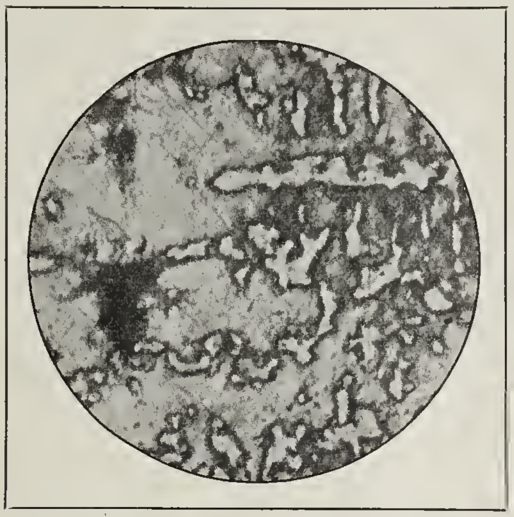


FIG. 3—STRUCTURE RESULTING FROM ANNEALING AT TOO LOW A TEMPERATURE
(Magnified 100 Diameters)

Iron and Its Carbon Content

Irons totally free from combined carbon are rare, the usual so-called gray irons having at least some part of their carbon in the combined form as Fe_3C. However, to consider an iron whose entire carbon content is in the graphitic condition, we deduce at once that only two metallographic constituents can be present, graphite and ferrite. A commercial gray iron as observed under the microscope is shown in Fig. 1. The graphite appears as long curved plates embedded in the soft ferrite matrix. These plates so effectively destroy the continuity of the ferrite that the ductility of the iron is removed. Where graphite occurs in small rounded particles as in malleable cast iron, the matrix exhibits the normal ductility and malleability of ferrite. Commercial irons as alread stated, normally contain some combined carbon, those with less than 3 per cent nearly always having some combined carbon.

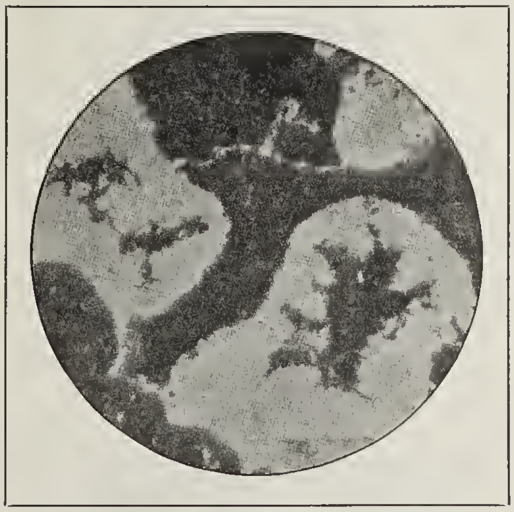


FIG. 4—TEMPER CARBON SURROUNDED BY FERRITE IN TURN ENVELOPED BY PEARLITE
(Magnified 100 Diameters)

Structure of Cast Iron

White cast iron is cast iron containing carbon only in its combined form and consequently free from graphite. Macroscopically, its fracture is white and metallic in appearance. The conditions already enumerated as being favorable to the production of gray iron must be absent, so that white irons are dependent for their occurrence upon either one or a combination of the following: First, rapid cooling during and below the freezing range; and second, high sulphur or manganese content. Indeed an iron may be white even with high silicon and low manganese and sulphur in case the freezing is sufficiently rapid, or it may be white even with slow freezing if the sulphur and manganese are sufficiently high and the silicon low enough. Microscopically, a slowly cooled white iron will consist of pearlite and cementite. Such an iron is illustrated in Fig. 2; the white areas are cementite, while the dark ones are pearlite not resolved at the magnification employed. White cast iron is nonmalleable and very hard and brittle. These qualities are due to the large amount of free cementite present, this constituent itself being hard and brittle.

In the majority of commercial irons as already stated the castings usually contain both combined carbon and graphite, usually from 0.25 to 1.50 per cent combined carbon and the remainder graphite. Where irons are partly gray and partly white in appearance, they are called mottled irons.

The subject of malleable iron has been dealt with by Dr. Moldenke, and by Leasman and Storey, and others. Malleable iron has not received its full quota of scientific attention, if published data can be any criterion. A great deal more is no doubt known, to a few, concerning the process of malleablizing than the altogether sparse literature would indicate, because of the secrecy which is supposed to and actually does overhang the process. Malleable castings are cast initially as hard white cast iron and are rendered somewhat malleable by, in part, graphitizing the cementite and converting the carbon into small rounded particles, and in part by burning out some of the carbon by the oxygen of the packing materials. In view of what has gone before it appears useless to dwell on the subject at greater length unless it be to point out how the metallographic microscope has served as an efficient tool in some of the researches made in this process. Photomicrographs by Storey show the influence of packing materials, temperature of annealing, and time of annealing in the malleablizing process. In Fig. 2 is seen a normal white iron where the carbon is all present in the combined state; the white areas represent cementite while the dark areas are pearlite.

The data obtained from Storey's researches show that when malleable is annealed for too short a time or at too low a temperature and slowly cooled, the structure consists under the microscope of ferrite and cementite and temper carbon, as shown in Fig. 3. Too rapid cooling after correct annealing results in a structure of temper carbon enclosed by ferrite, the latter being in turn enclosed by pearlite, as in Fig. 4. Proper annealing results in the structure shown in Fig. 5, consisting of ferrite and temper carbon.

Methods and Apparatus

In selecting microsections for examination under the microscope, it is usually not important to select the position in a casting from which the piece is taken, unless it is to observe local conditions. In the case of failure of metal in service, it is necessary that the sections should be taken from a position close to the fracture, as in many instances the casting may be sound with the exception of the part which failed locally. Stead remarked on this matter in the following manner:

"The importance of this is not always recognized, and specimens taken from positions far removed from the seat of failure are occasionally sent to the expert for examination and report as to the cause of failure—a proceeding which is equivalent to asking a medical practitioner to examine one's perfectly sound toe with the expectation that he will be able to tell why there is a tumor on his neck."

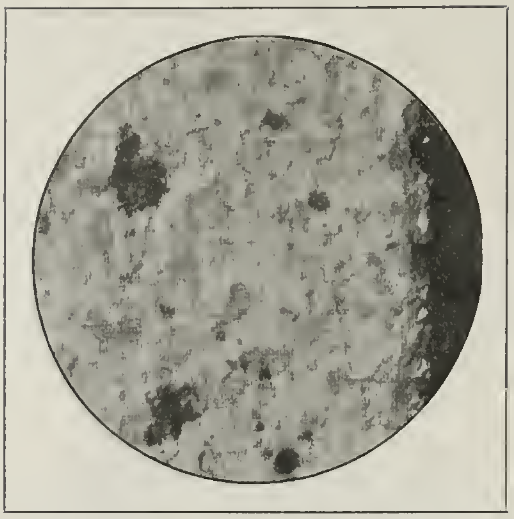


FIG. 5—MALLEABLE CASTING SHOWING CARBONLESS RIM
(Magnified 100 Diameters)

The use of motor-driven apparatus for grinding and polishing operations is to be recommended in preference to hand work, as the latter is tedious. Where a large number of microsections are to be prepared, as in routine work, power polishing is eminently more suitable.

For the detection of slag inclusions, porosity, oxides, sulphides, etc., the sections may be examined unetched. For the determination of the constituents and for distinguishing between occluded substances, it is necessary to etch. The sections are treated with reagents which have been found to be most suitable, or they may be heat tinted until the constituents assume differential oxidation films. The reagents in common use have been described in the literature of metallography, as has been the heat-treating method of Stead.

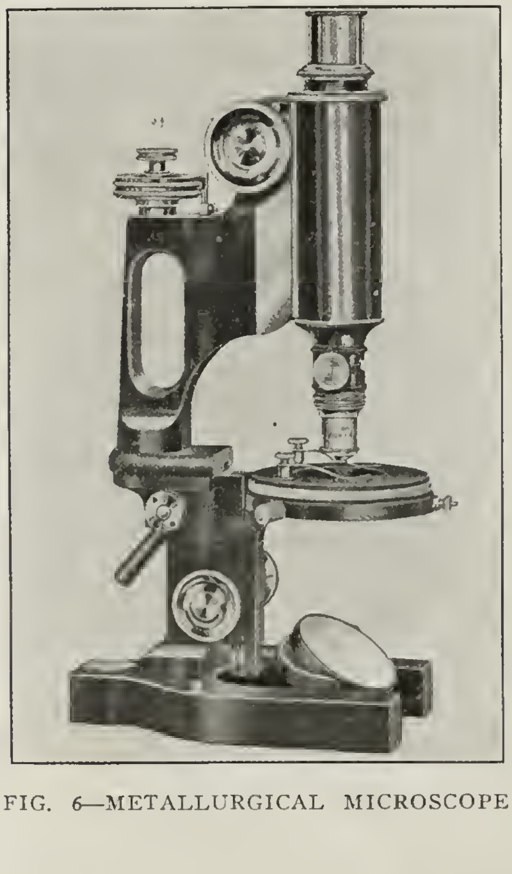


FIG. 6—METALLURGICAL MICROSCOPE

Any compound microscope fitted with an illuminator for opaque objects will serve for examinations, but it will be found best to obtain a metallographic microscope such as is supplied by various makers. A satisfactory instrument is shown in Fig. 6. The methods of examining and the apparatus required for photography have been described at length elsewhere and need not be dealt with in this paper.

Impurities in Iron

As is well known, the common impurities in cast iron, as in steels, are the elements sulphur, manganese, silicon and phosphorus. Since all cast iron which is not refined in steelmaking processes is used for making iron castings, the impurities present in the pig iron will be present in the iron castings, and the fundamental characteristics of those castings are direct functions of the percentages of the different impurities present. Carbon, either combined or graphitic, or both, is of course a constituent of all iron castings. The impurities mentioned exert a dual influence; first, upon the iron itself; and second, upon the carbon.

Sulphur in increasing percentages increases the amount of combined carbon present in any given iron, and when present as FeS the effect is even greater than when in the form of MnS. Having observed the fracture of an iron, the methods of metallography are valuable in supplementing the macroscopic observation. To employ these methods for the approximate determination of sulphur in cast iron, the following procedure is adopted: A piece of iron is polished and pressed firmly upon a piece of photographic silver bromide paper, which has been immersed in dilute sulphuric acid; the contact of the iron and the paper is maintained for a given length of time, and the amount of brown stain of silver sulphide formed is an indication of the percentage of sulphur present. This method has found considerable application in many steel works to determine segregation of sulphur in steel. The method has not found any wide use in the foundry, but there is no reason why it should not be useful there also.

The effect of manganese is to increase the combined carbon in an iron, but its influence is not as potent as that of sulphur. Also, it should be stated that since considerable of the manganese is in the form of MnS, it does not exert the effect of manganese in the elemental condition. Manganese robs FeS of its sulphur, so that the ultimate effect of manganese is to decrease the percentage of combined carbon present in the iron. Any manganese in excess of the amount required to form MnS is in the form of the manganiferous cementite, $(FeMn)_3C$, and consequently increases the amount of combined carbon. This effect of manganese is therefore apparently contradictory.

Effect of Phosphorus

Phosphorus element also exerts an apparently contradictory effect upon irons in that it tends to increase the percentage of combined carbon, but it also has the effect of lengthening the period of time of the mushy stage, i. e., the range between the liquidus and solidus. This increased period of time promotes the graphitization of cementite. Micrographically, the occurrence of the reaction, $Fe_3C = 3Fe + C$, can be recognized by the contiguity of the graphite and ferrite which are products of the reaction. Graphitization is promoted by the presence of silicon and occurs with greater rapidity at high rather than low temperatures. The phosphorus, by increasing the length of the mushy stage, consequently favors graphitization, and the combined carbon will therefore be lower. With low silicon and high phosphorus, the tendency for combined carbon to increase is strong; when silicon is high, the tendency is towards graphitization; when the phosphorus is high, chemically it has the effect of retaining carbon in the combined stage, regardless of the length of the mushy range. Phosphorus may then tend to keep the carbon in the combined form if other chemical influences, as silicon, are not potent; it may hasten the precipitation of graphite if the physical conditions are such that the graphite is bound to precipitate.

A word on the mushy stage may not be out of place: It exists, as already indicated, in the range of temperature between the liquidus and solidus. During this period, the cooling metal consists of a mechanical mixture of molten mother metal and solid particles of primary austenite. All cast irons pass through this stage with the exception of that iron having eutectic composition. The lower limit of the mushy range is constant for cast irons, free from impurities, at 1135 degrees Cent., the freezing temperature of the eutectic; the upper limit of the range varies with the carbon content on either side of the eutectic composition. Impurities may change the lower limit of the range.

In gray iron, that is one where extensive graphitization has gone on, almost all the phosphorus is present as phosphide of iron, Fe_3P, segregated in isolated masses throughout the iron. The phosphide of iron is readily recognized microscopically; it is not affected by dilute acids, but the metallic portions between the phosphide and the graphite are readily attacked. If then a polished micro-section be etched with dilute HNO_3, the phosphide will be seen bright under the microscope. Where the phosphorus is high, these bright spots of phosphide can be seen macroscopically, but when the phosphorus is low the microscope is required for their detection. Metallographic methods readily offer a procedure for determining whether an iron is high or low in phosphorus. However, microscopic analysis must be regarded as only approximate and cannot entirely supplant chemical analysis.

Silicon promotes the precipitation of carbon in the form of graphite; an iron containing say 3 per cent silicon will have practically no cementite, if the cooling is slow and the sulphur and manganese low. With 3 per cent silicon, the formation of austenite during solidification may be partially prevented, and graphite instead of cementite may be precipitated at 690 degrees Cent. Silicon is therefore an important element in control of foundry products because of its effect upon the condition of the carbon. Silicon probably forms with iron the silicide, FeSi, which is soluble in ferrite. There is no metallographic method of distinguishing silicon unless through a rough approximation arrived at from the graphite present. It is stated, however, that under similar conditions the greater percentage of silicon present in ferrite, the slower the etching of that constituent.

Conclusion

As has already been stated, it appears to be most singular that metallography has not yet rendered the quota of results to the foundry business which it is capable of, considered in the light of its immense value to steel manufacture. Originally, when the microscope was introduced as an aid in the control of steel products, it was held by some people that it would be able to detect everything that the chemical analysis failed to give. Patently, such claims have never been realized. Most of the metals and many of their alloys have been studied by means of the microscope, but a more complete knowledge is still desired. I do not think that anyone questions the value of the chemical laboratory as a method of control in metallurgical operations; still, the metallographic laboratory can render greater service when the results of its procedure are properly interpreted. Microscopic examinations when conducted by experts can more speedily explain the properties of both metals and alloys than can chemical analyses. The two, however, should be regarded as supplemental.

After reviewing everything, both for and against, the writer strongly affirms his belief in metallography as indispensable in metal manufacturing and fabricating processes, and that the foundry interests may profitably install apparatus to that end. Instances may be cited almost without end to justify the claim that appropriately guided scientific investigation pays—that it is a business asset. The time has arrived when all prejudices should be cast away, and when this method is appreciated more widely it will be recognized more widely as one of the most important advances in modern metallurgy.

Foundry Industry Leaps Forward

The past year is the first since 1910 which showed an increase in the net number of foundries in the United States and Canada. During each year between 1910 and 1916 the industry suffered a loss in the number of shops. This loss, which totaled 304 plants from April 1, 1910, to Aug. 1, 1916, was caused by the business depression which prevailed during part of this period and the tendency to concentrate manufacture by extending large plants and discontinuing the smaller shops. This latter procedure was the result undoubtedly of labor difficulties and inability to secure prompt shipments of equipment and supplies, conditions which have prevailed since the beginning of the war.

The net gain in casting plants in the last 15 months was 313, which, it will be noted, offsets the loss of the previous six years. According to figures compiled by THE FOUNDRY, 360 new plants have been added to the industry in the period under review, and during the same time, 47 shops have gone out of business entirely. A large number of concerns have been succeeded by new companies, have reincorporated or changed their names, but these are not included in the foregoing figures.

Pennsylvania leads the states in the number of new foundries with a total of 47. Ohio is a close second with 46. Illinois has gained 38 new foundries, 25 of which are located in Chicago. Michigan is next in line with 29 foundries, followed by New York with 28 and New Jersey with 27.

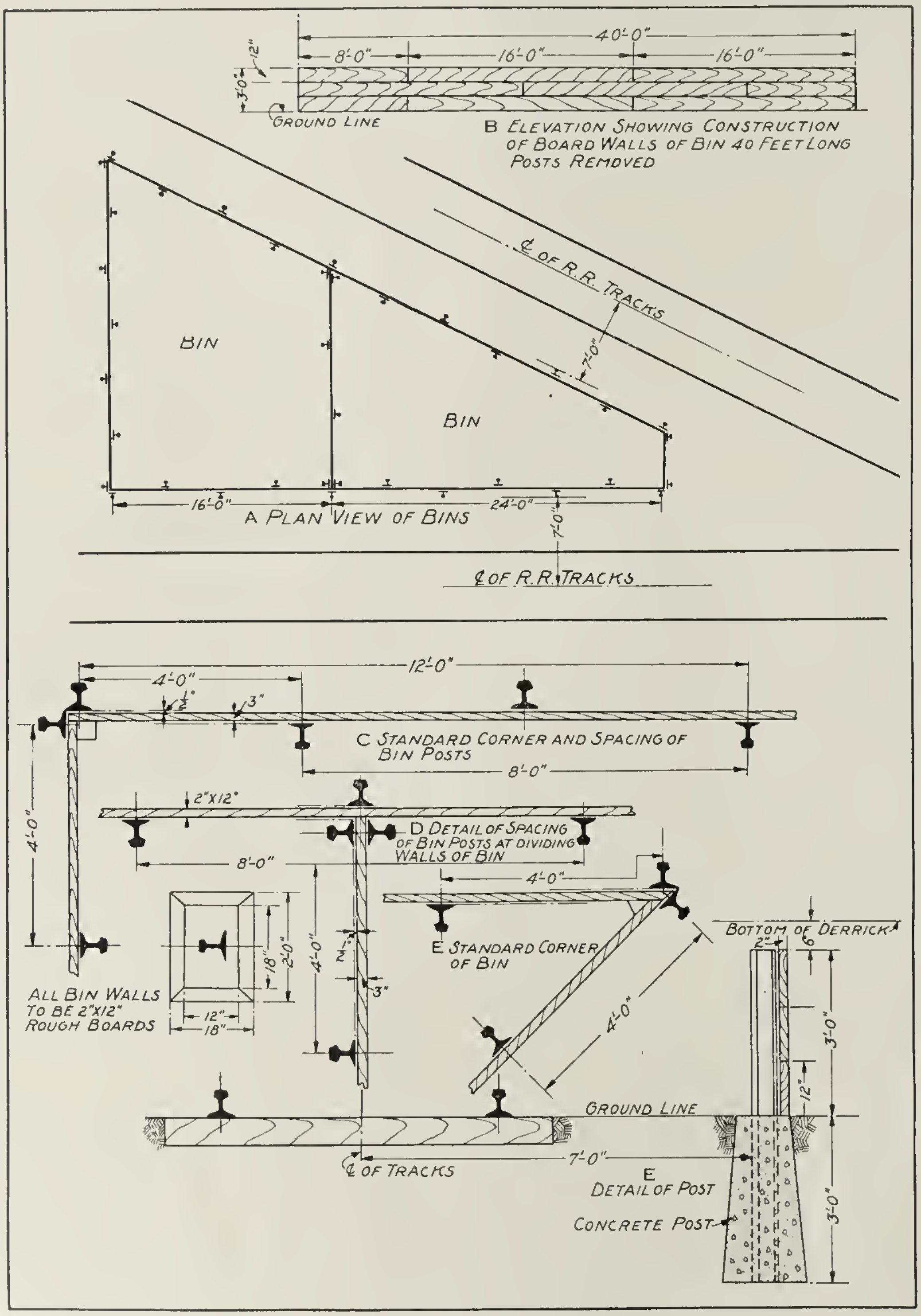
Design For Durable Storage Bins

By George W. Childs

In view of the present uncertain deliveries of raw materials, many manufacturers are finding it necessary to store large supplies to insure adequate stocks for emergencies. A group of storage bins, designed for coal, sand, ore, castings, scrap, etc., recently were constructed at the plant of the American Steel Foundries, Chester, Pa.

The bins are constructed of rough, yellow pine boards, 2 x 12 inches and 8 and 16 feet in length and scrap rails weighing 70 pounds and more per yard. The rails are 6 feet long and are set 3 feet deep in concrete piers. The bins vary in size and are located throughout the yard to suit plant conditions. They are numbered, and drawings are provided showing the locations of the various bins in the yard. A copy of the drawing, containing a numbered list and contents of each bin is conveniently displayed in the yard office.

In the accompanying illustrations, *A* shows a plan view of two bins, 12 feet and 24 feet in length, respectively, and the standard distance from the center line of the railroad tracks to the nearest side of the rail posts; *B* shows the construction of the board walls of bins 40 feet long. All board joints are staggered; *C* shows a standard corner and spacing of bin posts. The posts are spaced 4 feet apart and the clearance between the rails and the walls is ½ inch to allow the easy removal of the boards when required; *D* is the detail of the spacing of the bin posts at the dividing walls of the bin. *E* presents another form of the standard corner of bins. The drawing at *F* shows how the post should be set in the concrete pier. The rail extends 3 feet into the pier, and projects 3 feet above the ground line; *G* shows the standard location of the post relative to the centerline of the track.



DETAILS OF STORAGE BINS FOR ROUGH MATERIALS

The concrete piers are made of a mixture consisting of one part cement, two parts sand and four parts broken stone. The form of pier shown would required a wooden form, but it is said that this form need not be adhered to. As a substitute, the holes can be dug about 2 feet square and when the rail posts are placed in position the space can be filled with concrete. The rail posts are held in position in the holes, before the concrete is poured, by wooden strips extending from the sides of the posts to the sides of the holes.

It will be noted that the rail posts are staggered, every odd rail, as first, third, fifth, etc., is outside and every even rail as second, fourth, sixth, etc., is inside the board walls. This arrangement makes it possible to remove the boards one at a time, if desired, to allow wheelbarrows to be used in the bins.

It has been demonstrated at the plant of the American Steel Foundries that by placing the posts staggered as shown, the bins are amply strong for the pressure of the heaviest material coming against the walls.

For conveniently locating the inner and outer rail posts of the bins from the edges of the railroad tracks, wooden gages of the required dimensions should be provided.

Hard White Iron For Pipes

By W. J. Keep

Question:—We would like to have a cheap mixture suitable for making hard white iron for pipes, 8 feet long and 9 inches in diameter. The metal in these pipes is 1 inch thick.

Answer:—A cheap cupola mixture consists of white iron scrap, such as burned grate bars, with a slight addition of car wheels. Additions of wrought scrap to reduce the silicon low enough to make the castings white, also is advisable. The addition of a small amount of pure aluminum in the ladle will remove the gas and will make the iron fluid enough to produce sound castings. If you will visit a foundry where white iron sash weights are made, you will obtain considerable information regarding the practice which is similar to that you should pursue.

You might try a permanent cast iron mold for the outside of the pipe, which will give you the desired chill, together with a collapsible core. I also suggest that you melt the scrap in an air furnace.

How An Oil-Fired Malleable Furnace Operates

The Great Advantage of the Oil Furnace Lies in Its Uniformity of Operation—Labor Saving Also a Factor

AT THE session on malleable foundry practice at the annual meeting of the American Foundrymen's association held in Boston in September, J. P. Pero, superintendent, Missouri Malleable Iron Co., East St. Louis, Ill., chairman in charge of the meeting, described briefly the results of some interesting experiments on the use of fuel oil in place of coal for firing malleable melting furnaces. Mr. Pero said the oil fuel had proved entirely satisfactory in almost every way. Through the courtesy of the Missouri Malleable Iron Co. further particulars of this interesting innovation are now available.

The oil-burning furnace at the plant of the Missouri Malleable Iron Co. was specially designed for the purpose. It has now been in service about six months and the experimental period in its operation has been passed. The furnace has a maximum capacity of 20 tons, but during most of the time in which it has been in operation 12-ton heats have been melted. It has not been practicable to melt larger quantities owing to the proximity of other furnaces which it has been necessary to keep in operation to supply the total amount of iron required for each day's work.

The general arrangement of the oil-burning furnace is shown in Fig. 1. The oil burner takes the place of the coal grate at the end. The customary top blast is provided and four 2½-inch top tuyeres have been installed. It will be noted the furnace is drawn down at the throat and that the roof slants straight from the bridgewall to the stack. The melting hearth, bungs, rabbling doors, etc., are arranged in the usual manner. The furnace has steel plate sides reinforced with I-beam buck stays. A monorail trolley is provided for handling the bungs.

Details of Oil Burner

The details of the oil burner are shown clearly in Fig. 2. A burner of standard design built by W. N. Best, New York, is provided. The oil passes through a meter and enters the burner under a pressure of approximately 10 pounds per square inch. It is important that this pressure be maintained at the correct value. The necessary pressure is provided by a small centrifugal pump. The oil also is preheated to a temperature of from 135 to 150 degrees Fahr. The temperature of the oil also has an important bearing on its proper atomization and combustion. The oil is atomized by steam at a pressure of approximately 60 pounds per square inch. The steam is superheated before arriving at the burner by passing through a coil in the combustion chamber. The oil and steam are intimately mixed at the burner, from which the finely divided particles are discharged at high speed resulting in combustion at maximum temperature.

The large volume of low pressure air necessary for the correct burning of the oil in the combustion chamber is supplied by an end-blast shown clearly in Fig. 2. A 12-inch blast pipe is provided and the air enters the combustion chamber directly under the burner.

The combustion chamber is an important part of the furnace and its proportions were very carefully worked out by experiment. It is approximately 7 feet in length and extends the full width of the furnace. When operating conditions are correct, the flame extends but a very little way over the bridgewall. The air for the end and top blasts is provided by a 30-inch blower of standard type manufactured by the Buffalo Forge Co., Buffalo. The blower is direct-connected to a 10-horsepower, 220-volt direct-current motor furnished by the Wagner Electric Mfg. Co., St. Louis. The necessary oil pressure is created by a small motor-driven centrifugal oil pump. The oil is stored in a tank conveniently

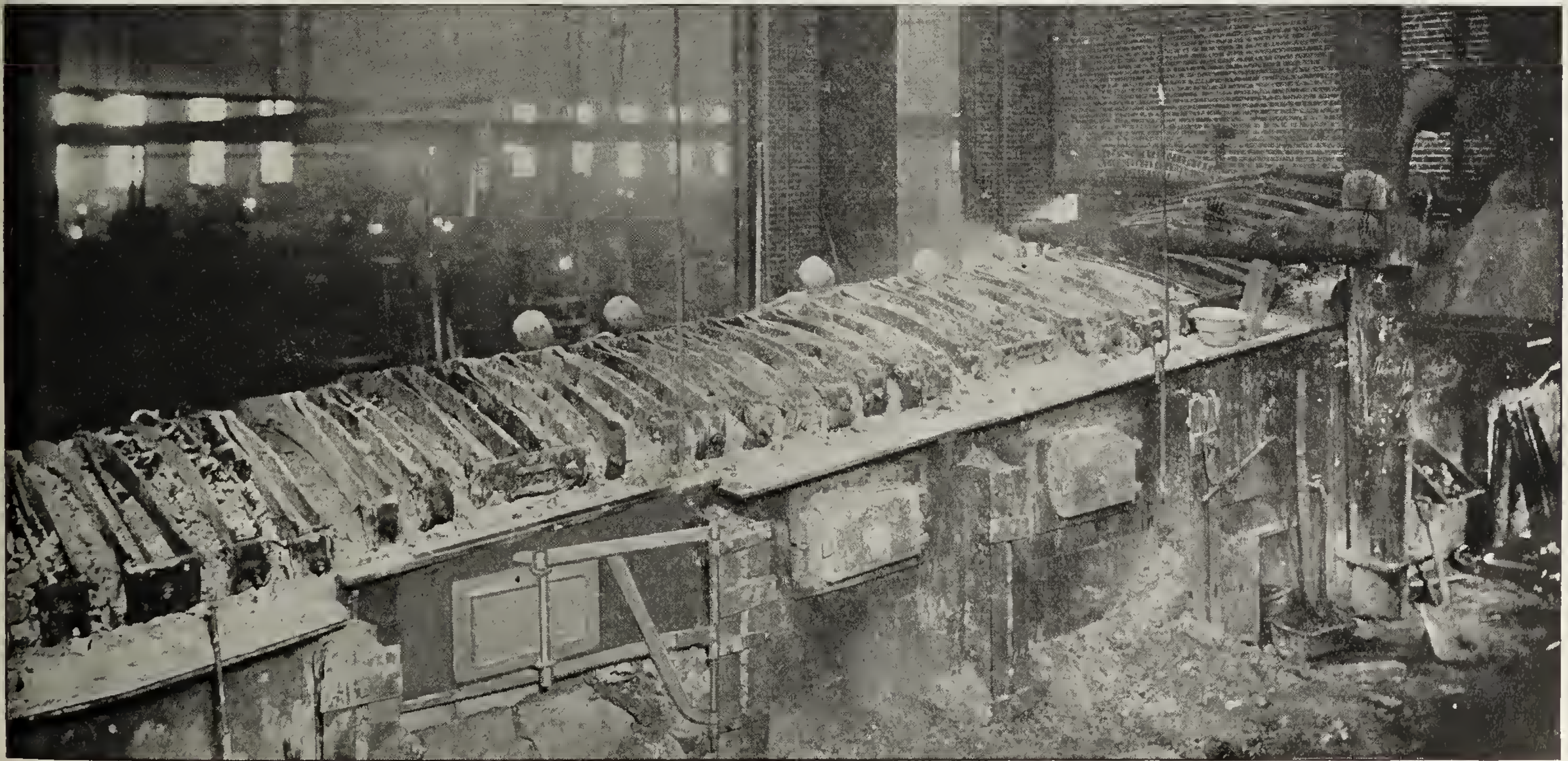


FIG. 1—GENERAL ARRANGEMENT OF OIL-FIRED AIR FURNACE SHOWING ROOF DESIGN AND IMPROVED DOOR

located near the receiving tracks. Another storage tank of 135,000 tons capacity is now under construction. Ordinary Oklahoma fuel oil of standard gravity is employed. At the present market it costs a little over 5 cents per gallon.

The arrangement of the oil piping leading to the burning, together with the location of the meter, pressure gage and oil-temperature thermometer are clearly shown in Fig. 2. The combustion of the oil and therefore the amount of heat generated in the furnace is controlled entirely by manipulating the small globe valve, *B*, Fig. 2, located in the oil-pipe line near the furnace.

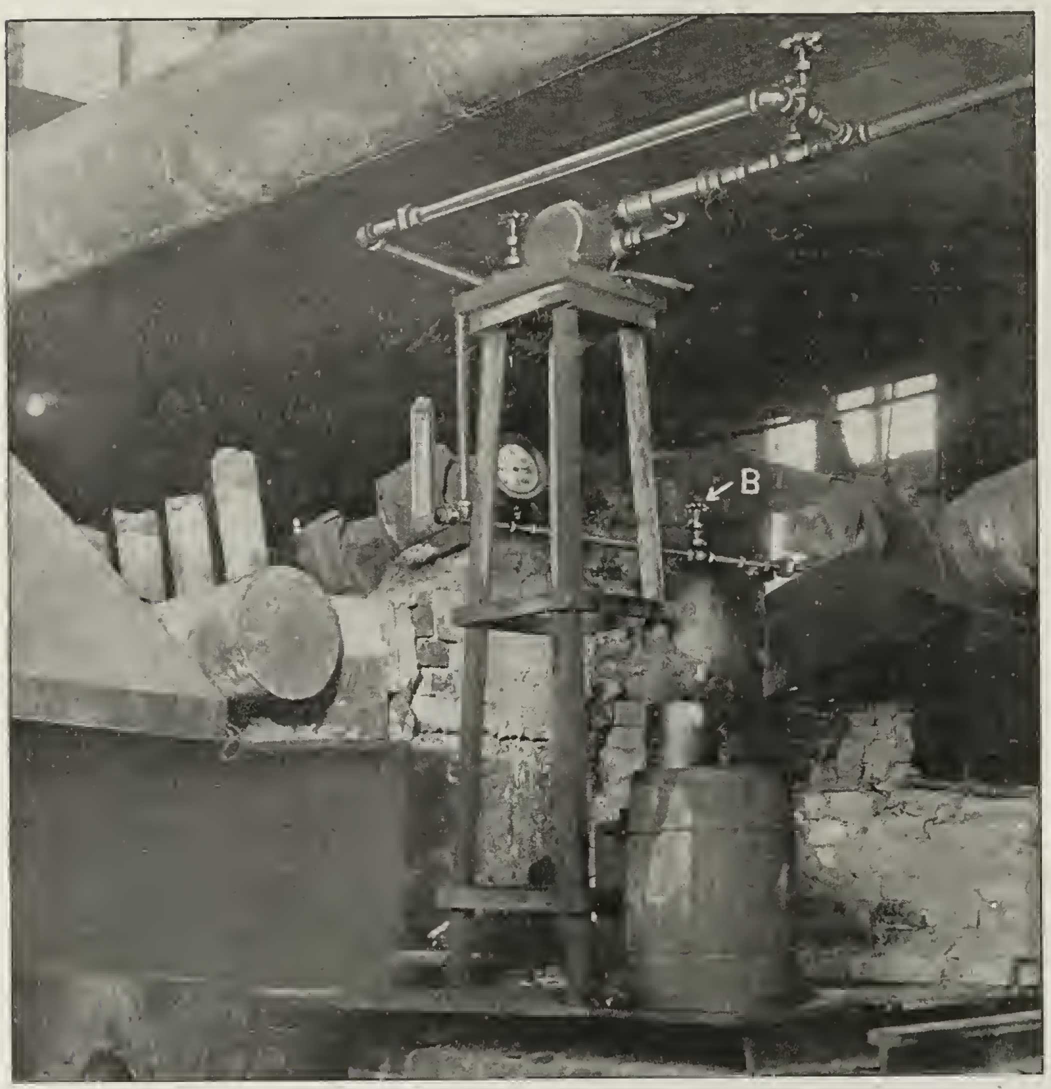


FIG. 2—ARRANGEMENT OF BURNER IN OIL-FIRED FURNACE

One man can readily control the operation of the furnace. In the case of coal-fired furnaces from two to four men are required depending on the weather. Firing air furnaces with coal in hot weather is unusually arduous and it is during the summer months that the oil-fired furnace exhibits its greatest economy.

Oil Consumption Moderate

Records kept by the Missouri Malleable Iron Co. show that the oil consumption varies from 68 to 72 gallons per ton when melting 12-ton heats. If heavier heats were melted somewhat lower consumption could be obtained. The fuel cost when burning oil, therefore, is $3.40 to $3.60 per ton of iron melted. Coal-fired furnaces require about 750 pounds of good West Virginia gas coal per ton of iron melted.

When melting 12-ton charges the morning heat can be put through the furnace in from 4¼ to 4½ hours. No difficulty is experienced in melting the afternoon heat in 3½ hours. The furnace is equipped with doors of a new type one of which is shown at the left in Fig. 1. By means of the double hinge arrangement, which is clearly illustrated, the door always closes tightly on its seat thus reducing heat losses and preventing the escape of gas and flames. The door is carried by a steel frame which is hinged on one of the I-beam stays.

In commenting on the advantages of the oil-fired furnace at the meeting of the American Foundrymen's association, Mr. Pero made the following remarks: "I believe that it won't be long before we shall all get away from hand firing. One of the primary aims of the operator of an air furnace is to obtain uniformity of product. I know I am getting better control of the chemical content of the iron in the oil furnace than in any of my hand-fired coal furnaces. I believe also that the wear and tear on the oil-fired furnace is very much less than on the hand-fired furnaces. In addition, the heats are turned out more quickly and more uniformly, in fact, you can almost set your watch by the heats. We are so well pleased with our oil furnace on which we have been experimenting since last April that we have decided to equip three more furnaces with oil burners.

"Now our daily reports do not show any economy of oil over coal. There is a material decrease in labor cost and there is also less maintenance cost, but the great advantage of the oil furnace lies in its uniformity of operation. This results from the fact that the heats can be accurately controlled. You can oxidize if you want to and you do not have to oxidize much if you don't want to. All the control is centered in a little valve. The heat units are used to best advantage in the oil-fired furnace. I have been surprised to find that I can operate with the flame extending just a little way over the bridgewall and still obtain sufficient heat. The stack is not being burned out and there is not much unconsumed gas sent up the stack."

Little Journeys of the Flint Shot Man

An exceedingly interesting 45-page booklet, entitled "Little Journeys of the Flint Shot Man", has been published by the United States Silica Co., Chicago, which describes the use of flint shot for sandblasting castings in more than 60 plants throughout the United States. This booklet was compiled by R. R. Shuman of the Shuman Advertising Co., 110 South Dearborn street, Chicago, who personally visited all of these plants and first-hand information regarding their sandblasting operations are given. The first chapter points out the advantages of sandblasting over other methods of cleaning castings and this is followed by a chapter entitled "The preparation of Metal Surfaces", which should prove of interest to all foundrymen. The various types of sandblasting apparatus also are reviewed and suggestions are included for making use of the waste dust and also for disposing of the waste. This is followed by a study of sandblasting methods with flint shot in such plants as the Allis-Chalmers Mfg. and the Falk Co., Milwaukee; Chicago Hardware Foundry Co., North Chicago; National Malleable Castings Co.; and others, equally well known. The use of the sandblast in the automobile industry also is reviewed at length and suggestions also are made for using flint shot for sandblasting purposes for preparing metal surfaces for enameling, rustproofing, cleaning nonferrous metal castings, etc.

Titanium and Aluminum Bronze

A well-arranged and well-illustrated 16-page booklet devoted to titanium bronze, has been issued by the Titanium Bronze Co., Niagara Falls, New York. A few of the many purposes to which titanium aluminum bronze may be applied are outlined and illustrations are included of some of the many castings made therefrom. It is used to advantage for parts requiring great resistance to vibration and abrasion, strength and wearing qualities, as well as having acid-resisting properties, making it particularly adaptable for gears, feed valves, pump valves, plunger rings, pump rods, acid fittings and structural pieces. Comparative photographs of the wear of a phosphor bronze pinion gear and one made from titanium aluminum bronze, are included. These show only comparatively slight wear on the titanium aluminum bronze pinion gear as compared to that of the gear made from phosphor bronze.

A 12-page booklet issued by this company, devoted to die-cast titanium aluminum bronze, shows many intricate parts successfully made from this metal. A special foundry has been equipped for this work and die-cast parts are being introduced as economical substitutes for sand castings, drop forgings, etc.

Malleable Iron and Its Uses

By Henry F Pope

IRON, as it is run from the furnace and poured into the molds in the process of making malleable iron castings, is not malleable at all but is extremely hard and brittle. When broken, it shows a white fracture. But this brittle iron is of such composition that when subjected to the proper annealing heat for the requisite length of time, it is transformed into an iron with entirely different physical qualities. After annealing, instead of showing a white fracture it shows a black one, giving it the name of "black heart". This distinguishes the malleable iron made in this country from that made in Europe, which has a steely fracture, due to the fact that the carbon is almost entirely removed by oxidation in the annealing process. The black fracture of American iron is due to the fact that in the annealing process the carbon, which in the original casting was all combined, has been separated out by decarbonization and is now found as free carbon or graphite of non-crystalline form deposited between the molecules of the iron. This form of carbon is called by Ledebur "temper carbon", to distinguish it from its other forms. The presence of a large amount of temper carbon gives the material its black appearance.

A Few Physical Properties

The iron itself, therefore, is left almost entirely free from any combination with carbon and possesses the malleable quality of wrought iron. It can be bent without fracture and withstands great shock and stress without breaking. It has the superiority of wrought iron in the respect of malleability without the sometimes objectionable fibrous structure of that material.

Some one will say: "Why use malleable iron any more when steel castings may be had?" That is a plausible question, for great strides have been made in steel casting production and certain castings have been changed from malleable iron to steel with improved results; but there are several reasons why steel will never displace malleable iron for a multitude of articles. In the first place, in most cases if the steel could be produced in the form and section of the malleable casting, it would be more expensive and no better; for it must be remembered that while the tensile strength of malleable iron is somewhat below that of soft steel, its elastic limit is just as high, which means that it will stand just as much punishment as the steel. Furthermore, it is easier and cheaper to produce many articles in malleable iron.

Poor Standards Reflected by Some Makers

Malleable iron has, unfortunately, not been produced in conformity with the best standards by all of its makers, and the poor iron made by some has brought much discredit upon the industry as a whole. There is no justification for this, because the inferior metal can be so easily distinguished from the good by the examination of the fractures of removed test lugs. All important castings should have test lugs cast on them for this purpose. Many manufacturers have, however, for several years given serious scientific study to their product with wonderfully good results, so that from many of them malleable iron can now be obtained of uniform quality and of greatly increased tensile strength without any sacrifice of ductility; for one peculiar feature of malleable iron is that while the tensile strength increases, the elongation also increases. This is not true of any other commercial metal.

There are two essentials necessary in the production of malleable iron. One is the proper composition of the hard iron and the other the proper heat treatment in the annealing process. With increased knowledge and with better practice, the former has been greatly improved and the latter is secured by a proper observation of the temperatures. The quality of malleable iron will doubtless be improved by the use of the electric furnace, which practically insures a proper mixture before the iron is poured, besides eliminating objectionable oxides.

Wide Range of Uses

Thus it can be seen that malleable iron has a usefulness which is entirely its own and which cannot be taken away. Years ago it began to be used advantageously for agricultural implements, all sorts of farm tools, wagons and carriages, harnesses, stoves, pipe fittings, and for many other purposes. Later, the railroads began to use it, for many parts of cars could be made lighter and less subject to fracture by the substitution of malleable for gray iron. The railroads also used it in places where the iron is exposed to the corrosive action of the weather, for malleable iron is as noncorrosive as any of the iron products and much more so than steel. More recently malleable iron has become popular in automobile construction. Other good qualities are its high permeability and its low magnetic hysteresis, qualities which render it desirable for certain electrical machinery.

Pure nickel has a lower resistivity than iron. At temperatures of 800 to 1000 degrees Cent. iron has a durability of 9 minutes, as against 32 hours for nickel.

Presented at the Cincinnati meeting of the American Iron and Steel institute, Oct. 26 and 27, 1917. The author is president, National Malleable Castings Co., Cleveland.

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Contents

How Automobile Motor Castings Are Made.................... 469
How Malleable Iron Has Improved.................... 475
Steel Castings for Ordnance Construction.................... 477
Scrap Nickel Anodes Reclaimed by Welding.................... 484
Unique Gray Iron Castings.................... 485
Pulverized Coal for Melting Malleable Iron.................... 487
Book Review 489
Casting Floor Plate and Bed for a Boring Mill.................... 491
How the War Affects Manufacture of Crucibles.................... 494
Suggestions for Melting Brass.................... 495
Problems of the Brass Founder.................... 496
Aluminum Casting Difficulties.................... 496
Segregation of Lead.................... 496
Melting Brass in the Cupola.................... 496
Metal from Brass Concentrates.................... 497
Aluminum Mixture for Pistons.................... 497
Bronze to Resist Mine Water.................... 497
What is Aluminum Nitride?.................... 497
Anti-Acid Bronzes 497
Making Vanadium Bronze.................... 497
The Role of Metallography in the Foundry.................... 498
Foundry Industry Leaps Forward.................... 501
Design for Durable Storage Bins.................... 502
Hard White Iron for Pipes.................... 502
How an Oil-Fired Malleable Furnace Operates.................... 503
Malleable Iron and Its Uses.................... 505
Contents 506
Co-Operation Thrives Under Stress.................... 506
Trade Outlook 506
New Equipment for Foundry and Pattern Shop.................... 507
What the Foundries are Doing.................... 510

Co-operation Thrives Under Stress

ONE of the subjects frequently discussed by manufacturers is that of co-operation between various departments. During the past decade no technical program has been considered complete unless it contained a paper on some phase of co-operation. Engineers have been urged to work in harmony with the operating heads, and employer and employe have been requested on each occasion to get together on a common basis.

It must be gratifying to the men who have persistently advocated co-operation to find that the war is effectively accomplishing what they have failed to do without its aid. No greater example of harmony between the component parts of a great industrial machine is afforded than the development of the standardized motors for the aeroplanes and motor trucks to be used by the government in France. In each case eminent engineers gladly contributed their genius to the perfection of an engine designed to simplify the work of manufacturers. Now that the designs have been completed the task has been shifted from the shoulders of the designing engineer to those of the production engineer and the operating officials. That these men have fully sensed their responsibility is indicated by the press reports announcing the early completion of motors constructed from the drawings sent out by government engineers. All that remains to make the triumph of industrial co-operation complete is for the manufacturers to turn out the standardized motors in such quantities that the American forces in Europe will never want for trucks or planes.

Trade Outlook

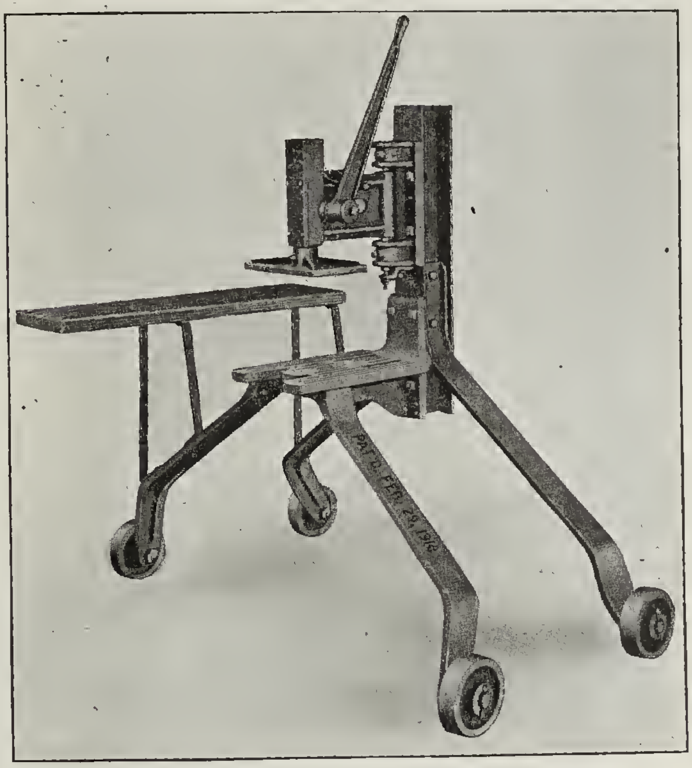
AFTER more than a month of groping about in the dark, manufacturers are beginning to grasp the significance of government price fixing. The foundry industry, like all other branches, was forced to tread water for a few weeks pending the determination of differentials and other details necessary to make the schedule operative. At the present time the prices of foundry iron and coke have been well established and sales of these materials are being made at the government quotations. Hundreds of thousands of tons of foundry and malleable iron have been sold at the fixed prices of $33 and $33.50 during the past few weeks. These sales call for delivery during the first half of 1918. Although the placing of freight cars for coke shipment has received the attention of the priority board, the car supply has not yet reached the promised 100 per cent basis. During the third week in October the average supply was 75 per cent, a ratio not calculated to aid the coke-oven operator in maintaining a reliable force of labor. Coke is held at $6, Connellsville. Other prices established by the government are as follows: Basic iron, $33, valley; gray forge, $32, valley; and malleable iron, $33.50, valley. Bessemer iron has been set at $36.30, valley, subject to revision.

New Equipment for the Foundry and Pattern Shop

Fool-Proof Electric Switch—New Type of Roll-Over Machine—Gravity Conveyor—Sand Tempering Machine—Arch for Annealing Ovens

THE H. W. Cooper Saddlery Hardware Mfg. Co., Moline, Ill., now makes a complete line of hand squeezers, having added two types of portable machines. Heretofore this company built only machines of the stationary type, but to complete the line and to meet the needs of the foundry trade it was decided to add the two portable machines. One of these portable machines straddles the sand pile and the other follows the sand pile as it is depleted in the making of molds.

All the operating parts of these machines are above the table and the number of these parts has been reduced to a minimum. The swinging head is balanced on hardened steel centers and as it can be readily swung by the molder it is convenient both for bench molding and squeezer work. All parts are made of steel, malleable iron and semisteel castings. Flasks up to 12 x 24 inches can be handled and the machines are especially adapted for work in gray or malleable iron and brass or aluminum foundries. One of the machines is shown in the accompanying illustration, which indicates how the body of the machine clears the sand heaps.



PORTABLE SQUEEZER MOLDING MACHINE

"Turning Waste Into Profit" is the title of a 28-page pamphlet issued by the Prest-O-Lite Co., Indianapolis, which is devoted exclusively to the possibilities of reclaiming broken and worn machinery and metal parts for service by the oxy-acetylene process. Containing 82 illustrations it pictures and describes representative reclamation welding work in practically every branch of industry. This booklet points the way for the economical and rapid recovery of many parts that otherwise might be scrapped.

New Type of Roll-Over Molding Machine

A unique roll-over molding machine has been developed by the American Molding Machine Co., Terre Haute, Ind., from designs made by W. C. Norcross, president and general manager. It is of the combined roll-over jolt type and is operated with compressed air. A single air cylinder controls both the roll-over and the ramming functions instead of separate units, usually employed. The three accompanying illustrations show the machine in different operating positions. Fig. 1 is a view of the mold before it is completely rolled over and dropped upon the jolting table. In Fig. 2, the mold is shown upon the jolting table and

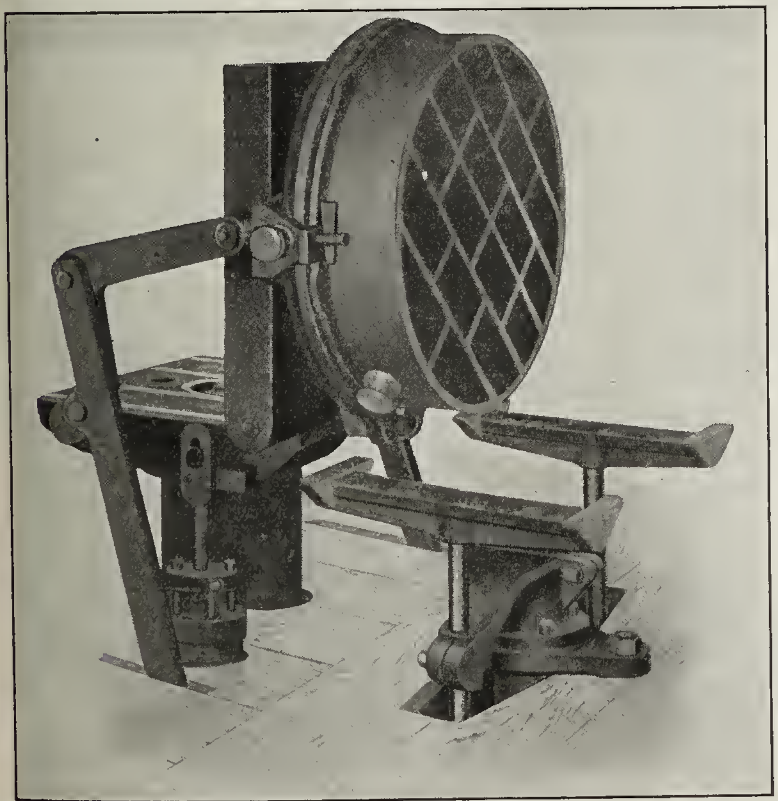


FIG. 1—MOLD BALANCED IN CENTER OF ROLL-OVER OPERATION

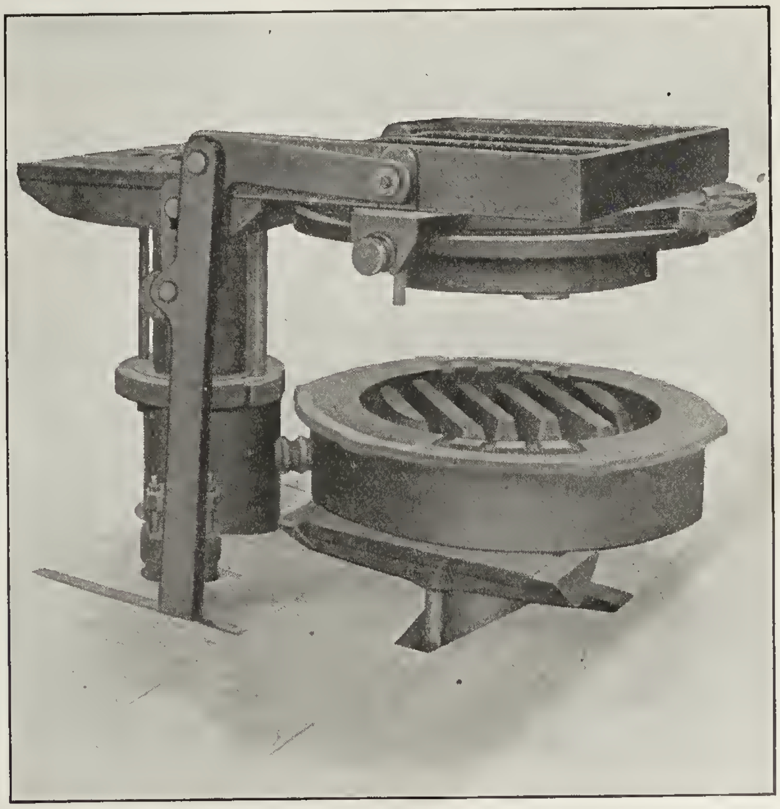


FIG. 2—MOLD ROLLED OVER IN PLACE ON JOLT TABLE

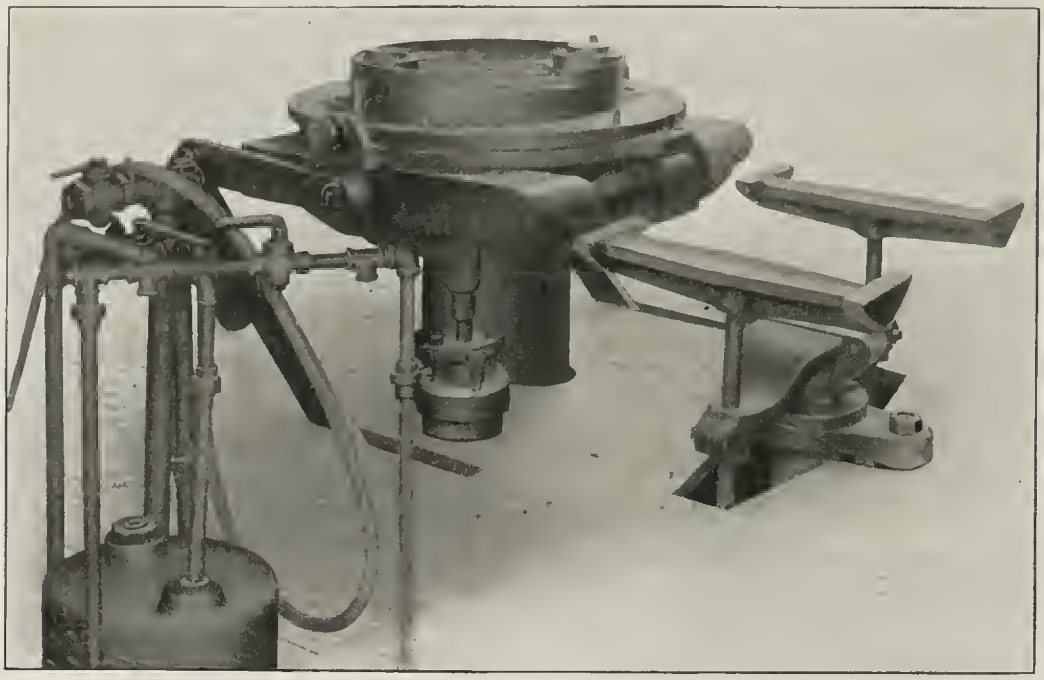
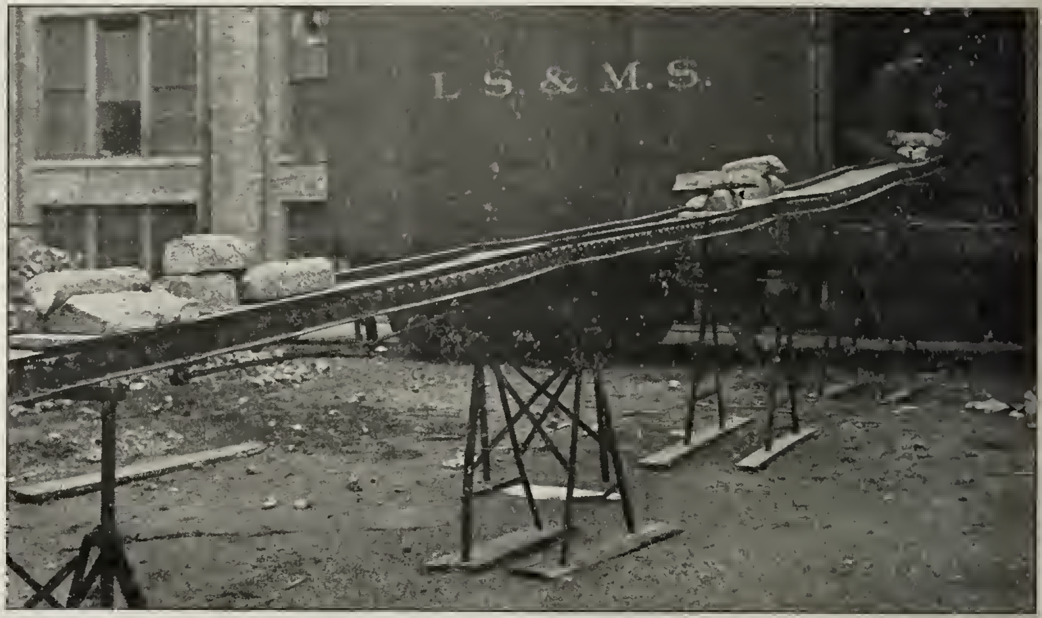


FIG. 3—RAMMING IS QUICKLY ACCOMPLISHED BY A 10-INCH AIR CYLINDER

Fig. 3 is a view of the machine showing the ramming operation. When jolting the mold, the cylinder operates in the usual manner; however, for the roll-over operation, a unique link motion and an automatic latch are brought into play. The mold is balanced at the center and little effort is required to roll it over. An oil-filled balancing cylinder, placed beneath the table, is provided to steady the roll-over operation. The flask is turned onto an automatic ball-and-socket leveling device that is self-compensating for any irregularities in the flask or the mold. When these supports take their bearing, the weight of the mold causes the hinged socket to grip the ball positively.

Gravity Conveyors for Foundry Materials

Gravity conveyors, through their several advantageous characteristics, have created a distinct field of application where it is desired to move materials economically and rapidly. The introduction of this labor and time saving means of handling materials has eliminated much lost motion and has served to effect considerable savings. In foundries, pig iron may be moved with a minimum of effort from railroad cars to the storage pile, from the storage pile to the cupola; molds may be carried to the cupola spout, and the finished castings conveyed from place to place by portable sections of gravity conveyors. The accompanying illustration shows a conveyor made by the Minnesota Manufacturers' association, North St. Paul, Minn. The steel rollers are provided with ball bearings which operate in hardened steel races. A special lock nut and washer holds the ball bearing stud securely in the angle iron side frame, and permits of easy removal of single rollers.



UNLOADING PIG IRON WITH GRAVITY CONVEYOR

Molding Sand Revivifier

In the operation of a continuous foundry, it is necessary to give the problem of keeping the sand in proper conditions careful attention. In some cases it has been found the sand has a tendency to form small hard balls which impart rough surfaces to the castings. In other foundries it has been found that the sand gets so hot that the molds dry out before they are poured. In an effort to overcome these difficulties, the Link-Belt Co., Chicago, has designed a new machine which is known as a molding sand revivifier. The principal element of the machine is a horizontal shaft on which beater arms, made of flat bars, are mounted. These arms are set at opposing angles so that the sand delivered to one side of the machine is thrown diagonally across to the other side, thus receiving a thorough mixing and aerating. The main shaft runs at 800 revolutions per minute and it is claimed that sand balls and hard lumps are promptly broken up by the beater arms.

The beater throws the sand against

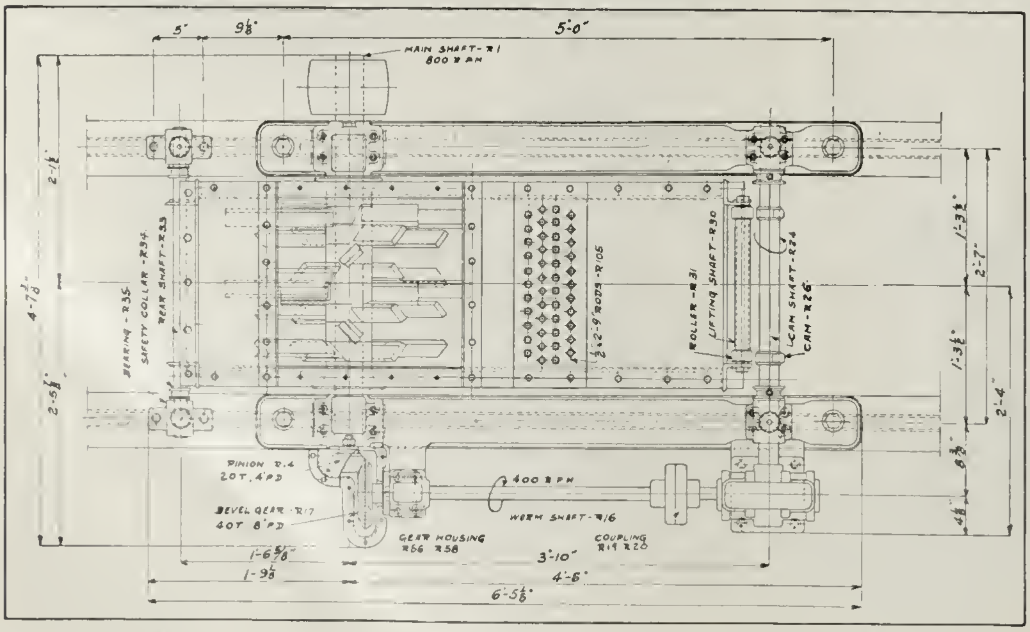


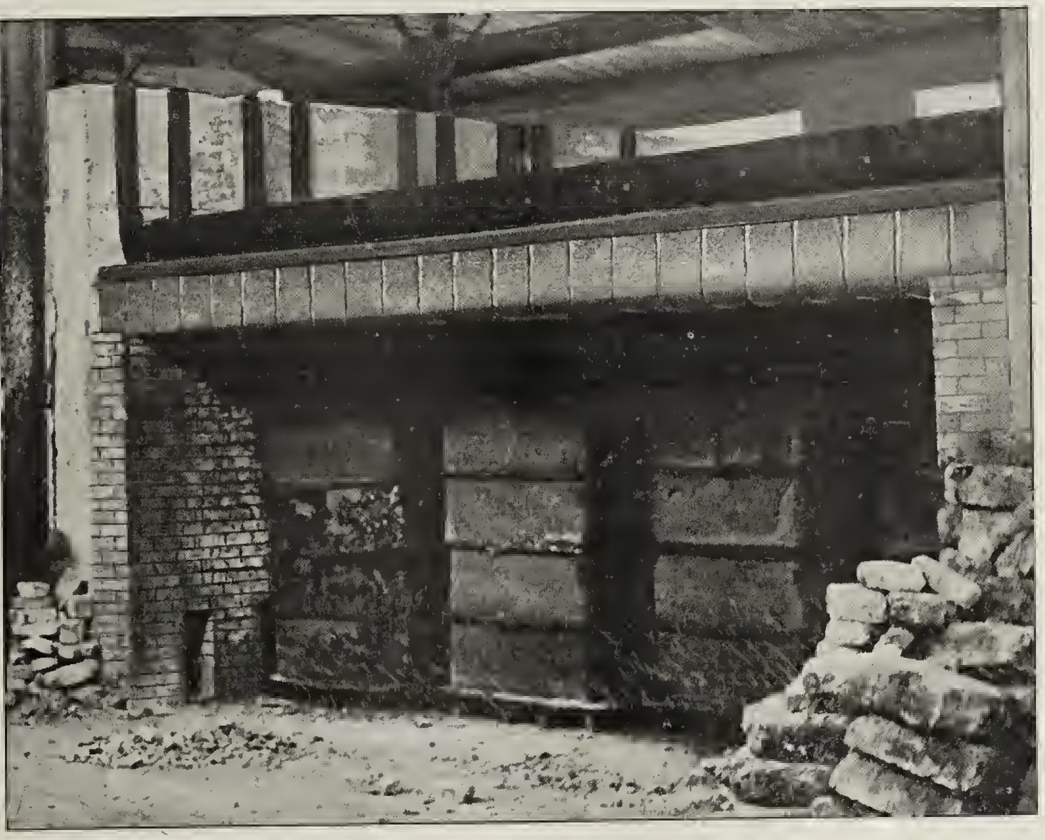
DIAGRAM SHOWING CONSTRUCTION OF SAND REVIVIFYING MACHINE a curtain of hinged rods which prevents the air from swirling around inside the shell of the machine and carrying the sand with it. The whole shell is pivoted at the rear and is so suspended that it is lifted a distance of 1½ inches about 30 times a minute by a cam. The cam drops the shell on a block of wood and the shock causes the shell and rods to vibrate, with the result that particles of sand that ordinarily would adhere to the mechanism are shaken off. It is claimed, therefore, that the machine is always clean and in conditions to do effective work. Also it is stated the usual increase in the temperature of the sand incident to pouring is reduced at least 50 per cent by passing the material through this machine.

Roof Arch for Annealing Ovens

A flat, suspended-type roof arch for annealing ovens in malleable foundries has been developed by the M. H. Detrick Co., Chicago. This arch, which is the result of considerable experimental work, is said to have indicated through trial installations that a uniform distribution of heat may be maintained which eliminates the possibility of hard malleables due to unequal annealing in various parts of the oven.

The accompanying illustration shows a flat, suspended arch in use at the plant of the Rockford Malleable Co., Rockford, Ill. In this type of roof arch, the fire bricks are suspended like pendulums from I-beams which rest upon the side walls. This construction eliminates the side thrust inherent to sprung arches and does away with buck-stays.

The fire bricks used in the arch of the Rockford furnace are 6 x 10½ x 10½ inches and are grooved on the top surface to receive the flange of a casting having an I-beam cross-section. Each casting supports 10 bricks, making each roof section 6 inches wide and 5 feet long. Successive rows suspended from I-beams resting on the side walls and spaced at 5-foot intervals comprise the roof of the oven. Eyelets in the castings permit the lifting of any row from the roof as desired. The opening in the roof thus made provides space to remove any brick in the row that may require replacing. Expansion and contraction are matters of automatic adjustment as each brick or tile is supported individually and no strains or stress are set up in the arch as a whole.

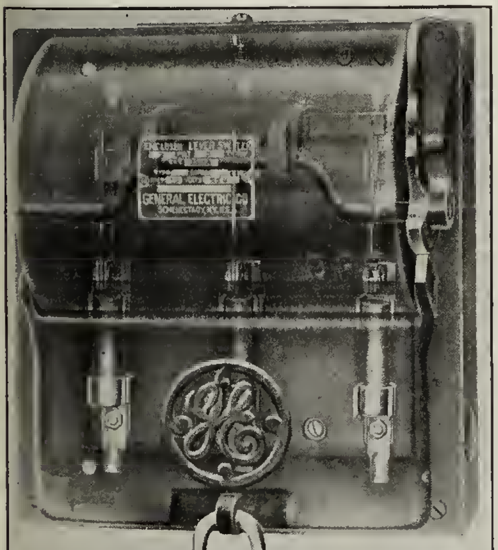


FLAT SUSPENDED TYPE ROOF ARCH DESIGNED FOR ANNEALING OVENS

A Fool-Proof Electric Switch

A new type of lever switch enclosed in an iron casing, recently has been developed by the General Electric Co., Schenectady, N. Y. The accompanying illustration not only shows the exterior protective casing, which is of sheet metal, but also reproduces in phantom the working parts and the slate base. The padlock prevents "outsiders" from tampering with the fuses in the lower part of the switchbox. Moreover, the switching lever at the upper right-hand side cannot be closed while the covering over the fuses is open, and vice versa.

When two or three operators are involved it has been observed that although one of them may throw on the switch with perfect safety, he may endanger another operator working on a machine whose motor gets its current through the switch. To meet this conditions three locks, each controlled by a different individual, may be used, thus enabling all operators to keep in touch with what is going on. The switches can also be provided with spring catches which must be pressed down while the switching lever is moved. Both hands are thus required to switch the electricity on or off and further safety is achieved.



ENCLOSED LEVER SWITCH

Plan Program for 1917-1918

The Birmingham branch of the British Foundrymen's association has outlined an exceedingly comprehensive program for the coming season. The papers to be presented at the various meetings follow:

Oct. 27.—Presidential address by J. Shaw, of Dudley, on "The Relationship between the Drawing Office Pattern and Molding Shops."

Nov. 24.—Lecture by Prof. T. Turner, the University, Birmingham, on "The Use and Construction of Graphic Diagrams."

Dec. 8.—Joint meeting with the Staffordshire Iron and Steel Institute. J. E. Hurst, of Manchester, will present a paper on "The Re-heating of Gray Cast Iron with Special Reference to Combustion Engines."

Jan. 26.—M. Riddell, of Glasgow, president of the Scottish branch of the British Foundrymen's association, will present a paper on "Permanent Molds."

Feb. 23.—Second joint meeting with the Staffordshire Iron and Steel Institute. J. E. Fletcher, of Dudley, president of the Institute, will lecture on "The Production of Steel Castings."

March 9.—"Jolt Ramming Molding Machines" will be discussed, the subject to be introduced by H. Pemberton, of Derby.

March 23.—Annual meeting and election of officers. Three papers also will be discussed as follows: "Coke-fired Furnaces," by H. L. Reason, Birmingham; "Gas-fired Furnaces," by F. H. Hurren, Coventry and "Oil-fired Furnaces," by Andrew Harley, Coventry.

In making blacking for molds and cores, one-half pint of molasses to a common-size pail filled with blacking is all that should be used.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Magnus Co., 22 Brush street, Detroit, brass founder, is building a $35,000 plant.

The Wizard Foundry Co., North Attleboro, Mass., will erect an addition to its foundry, one story, 30 x 100 feet.

The American Car & Foundry Co., Huntington, W. Va., will erect machine and blacksmith shop at a cost of $30,000.

The Gray Foundry, Inc., Poultney, Vt., is building an addition, 28 x 70 feet. A heating plant, 20 x 25 feet, also will be built.

Leitelt Bros., 7731 South Chicago avenue, Chicago, are building a brass foundry, 46 x 77 feet, at a cost of $8000.

A permit has been granted the Arth Brass & Aluminum Castings Co., Cleveland, to build a foundry addition, 18 x 20 feet.

The Golden Gate Brass Mfg. Co., San Francisco, will build a $12,000 foundry on Second street.

A contract has been awarded for the erection of a $35,000 foundry for the Jacob Wilson estate; J. W. Harrison is manager.

The Williams Mill Mfg. Co., Texarkana, Ark., recently incorporated with $100,000 capital, will erect a foundry and machine shop.

The Standard Brass Castings Co., Oakland, Cal., contemplates the erection of a $30,000 plant addition on a site recently purchased.

A contract has been awarded by the Pequonnock Foundry, Inc., Bridgeport, Conn., for an addition to its foundry.

The Buffalo Foundry & Machine Co., Buffalo, has increased its capital stock from $500,000 to $1,500,000.

The Regent Brass Foundry Co., Marysville, O., will increase the number of furnaces in its foundry from five to 16.

The capital stock of the Coeur d'Alene Hardware & Foundry Co., Wallace, Idaho, has been increased from $500,000 to $1,000,000.

The Richards Mfg. Co., Bloomsburg, Pa., is now operating its foundry which has been idle for a long period.

The Canada Iron Foundries, St. Thomas, Ont., has purchased a plant and will equip it for the manufacture of special castings.

The Woodward Machine Co., Wooster, O., is building a plant, 80 x 110 feet. The company's foundry at Orville, O., will be removed to Wooster.

The Gilliam Mfg. Co., Canton, O., has increased its capital stock from $800,000 to $1,500,000 to provide funds for erecting further additions to its foundry.

The Buffalo Foundry & Machine Co., Fillmore avenue and East Ferry street, Buffalo, will erect a 1-story, 28 x 174-foot pattern shop at a cost of $20,000.

The Bassick Co., Universal Caster & Foundry Co. division, 574 Ferry street, Newark, N. J., will erect a 1-story, 75 x 100-foot addition to its foundry.

A permit has been obtained by the Acorn Refining Co., 8205 Franklin avenue, Cleveland, to erect a gray iron foundry, 60 x 116 feet.

A foundry is being erected by the Standard Plating Co., Anderson, Ind. G. A. Robinson is manager of the company.

The Federal Steel & Mfg. Co., Minneapolis, will build a plant, including a foundry, 100 x 125 feet, and three machine shops, each 110 x 400 feet. The estimated cost is $500,000.

The Standard Crucible Steel Castings Co., 719 Thirty-first street, Milwaukee, will build a brick and concrete addition, one story, 30 x 60 feet.

Plans have been prepared for an electric steel foundry, 80 x 140 feet, to be erected for the Edward Valve & Mfg. Co., East Chicago, Ind. The estimated cost is $15,000.

The West Michigan Steel Co., Muskegon, Mich., is building two additions to its foundry, 42 x 150 feet and 48 x 100 feet, at a cost of $21,000.

An addition will be erected by the Buhl Malleable Co., Adair and Wight streets, Detroit, on property recently purchased adjoining its present plant.

Plans have been prepared for a foundry and forge plant to be erected for the Southern Illinois Machine & Foundry Co., Murphysboro, Ill. The estimated cost is $35,000.

A $200,000 plant, 90 x 200 feet, will be erected at Christina and Exmouth streets, Sarnia, Ont., by the Romeo Foundry Co., Port Huron, Mich.

Edward C. Aylward, formerly associated with the Aylward Sons Co., Neenah, Wis., will establish a gray iron foundry in that city. A 60 x 90-foot plant will be erected.

A contract has been awarded for the erection of a 2-story, 26 x 40-foot addition to the plant of the Stillman White Foundry Co., Providence, R. I.

The Canadian Brass Co., St. Catharines, Ont., manufacturer of plumbers' supplies, brass fittings, etc., will build an addition to its plant to cost $15,000.

The Pacific Car & Foundry Co., Seattle, has been incorporated with $1,000,000 capital, by William Pigott, O. D. Colvin, John, James F. and Robert L. Twohy.

The James A. Brady Foundry Co., Thirty-fifth street and Ashland avenue, Chicago, has increased its capital stock from $25,000 to $300,000.

The Connecticut Brass Foundry Co., Waterbury, Conn., has been incorporated with a capital of $10,000 by Franklin W. Cohen, Samuel I. Liftig and Henry L. Silver.

Prack & Perrine, 803 Keystone Bank building, Pittsburgh, are preparing plans for a $50,000 foundry, 165 x 241 feet, to be erected for the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

The West Bend Aluminum Co., West Bend, Wis., will build two additions to its plant, 75 x 195 feet and 50 x 60 feet, respectively. Abount $75,000 will be expended on the buildings and equipment.

The Nelsen Mfg. Co., Chicago, contemplates the erection of a one-story plant at Southport and Diversey avenues, which will include a foundry, enameling and case-hardening departments and general offices.

A gray iron foundry has been established in Milwaukee by the recently organized Atlas Foundry Co. The new company has been capitalized with $10,000, by Orvel A. Meyer, formerly of La Salle, Ill., and George P. Gerlinger, vice president of the Gerlinger Steel Casting Co., West Allis.

The Mt. Vernon Foundry & Engineering Co., Mt. Vernon, O., has been incorporated with $100,000 capital by James J. Sexton, George L. Mooney, R. C. Evick, John W. Mullin and W. L. Robinson.

The Keystone Brass Co., New York, has been incorporated with $10,000 capital to engage in the foundry business. The incorporators are E. A. Alafberg, S. L. Cohen and G. C. Norton, 617 Fifth avenue.

Barker & Co., New York, have been incorporated to conduct a foundry and machine shop business with $500,000 capital stock. A. Skillman, E. E. Hurley and A. Foshay, 120 Broadway, are the incorporators.

The Suffolk Casting & Supply Co., Boston, has been organized with a capital stock of $25,000. The incorporators are J. Jefferson Richards, L. B. Ellis and Sylvester D. Devlin, Everett, Mass.

The South Jersey Foundry Co., Camden, N. J., has been chartered with $250,000 capital to engage in the manufacture of cast iron pipe. The incorporators are Herbert J. Koehler, K. L. Fraiser and J. F. Sutton.

The J. L. Simpson Co., Bellefontaine, O., has been incorporated with $25,000 capital to engage in the manufacture of castings. J. L., H. S., E. M. and E. J. Simpson and Harry H. Morrow are the incorporators.

The Chelsea Foundry Co., Chelsea, Mass., has incorporated with a capital stock of $35,000. Edward F. Maguire, Morris M. Broomfield and P. M. Broomfield are the incorporators.

The Davis Mfg. Co., Enid, Okla., will build a plant, including a machine shop and foundry, three stories, 50 x 110 feet, to cost $50,000. The company will manufacture rotary separators and threshers.

The Herreshoff Mfg. Co., Bristol, R. I., has awarded the contract for a 2-story, 30 x 36-foot addition to its foundry and a 3-story, 60 x 80-foot storage building. Electric traveling cranes will be installed in the latter.

The Lansdale Foundry Co., Lansdale, Pa., has increased its capital stock from $25,000 to $100,000. The capacity of the plant recently has been doubled to provide facilities for producing work for the United States government.

A contract for a 280 x 300-foot foundry to be erected at the United States arsenal, Watertown, Mass., has been awarded to the Stone & Webster Engineering Corp., Boston. The total expenditure for building and equipment will approximate $800,000.

R. W. Benbridge, H. C. Benbridge and B. H. Benbridge have incorporated the Benbridge Foundry, Inc., Terre Haute, Ind., with a capitalization of $25,000. The new company will take over the plant of the United States Scale & Foundry Co.

The Liberty Ordnance Corp., New York City, has been incorporated with $15,000 capital stock to conduct a foundry and machine shop. The incorporators are F. H. Brownell, T. Pomeroy and R. P. Branley, 2386 Grand avenue.

The FOUNDRY
December 1917
CLEVELAND, OHIO.
Vol. 45, No. 12 Whole No. 304

Agreed Prices and Their Meaning to Foundrymen

Influence of Labor on Cost of Castings Complicates Problem of Price Fixing—Rates on Old Material Prove Distinct Surprise

FOLLOWING the establishment of prices on pig iron, coke and a limited number of grades of scrap, the revision of gray and malleable iron, steel and nonferrous metal casting prices to conform to these schedules is to be discussed. Owing to the large number of plants involved and the variety of patterns to be considered, the undertaking is a stupendous one, yet it is not without the possibility of accomplishment. The problem is unlike that of any other industry in which price price control has become effective. Contrasting the manufacture of castings with that of pig iron and rolled iron and steel products, the labor factor is of major importance in the one and is a minor element in the other. On the average casting, the labor involved, to a large extent, governs the price and the metal entering into it, with the exception of brass, bronze and aluminum, is actually of minor importance. Therefore, in considering the question of price establishment in the foundry industry, labor is the item of first importance. That an equitable basis will be evolved that can be made to apply to all branches of castings manufacture is certain, and when this has been decided upon the work of price revision will be greatly simplified.

Foundry Iron, Scrap and Coke Prices

FOUNDRY PIG IRON

	Gross ton at furnaces
No. 2, Silicon, 1.75 to 2.25	$33.00
Malleable	33.50
Bessemer	36.30
Basic	33.00
Lake Superior charcoal, Si. 1.25	35.50
Silvery, Si. 6 per cent	40.00
Low phosphorus, copper bearing	50.00
Low phosphorus, copper free	53.00

OLD MATERIAL

	Gross ton, f. o. b. consuming point
No. 1 heavv melting steel	$30.00
No. 1 railroad wrought	35.00
Cast iron borings	20.00
Machine shop turnings	20.00

COKE

	At the ovens
Beehive	$7.00

On Friday, Nov. 16, a meeting of the open-hearth, converter, crucible and electric steel casting manufacturers was held in the Waldorf-Astoria, New York, for the purpose of adopting a method of procedure in establishing prices to conform with the agreed quotations on pig iron and steel products. More than 100 foundrymen were in attendance and the expressions of aid and support to the government, in whatever form the request might be made, were unanimous. A resolution was adopted pledging the steel casting plants of the country and their output, their organizations, etc., to the government. For the purpose of co-operating with the general committee of the American Iron and Steel institute in establishing prices on steel castings, the following committee was appointed:

Chairman, G. H. Johnson, Isaac G. Johnson & Co., New York; E. S. Knisely, Bethlehem Steel Co., South Bethlehem, Pa.; H. D. Hammond, American Steel Foundries, Chicage; H. E. Field, Wheeling Mold & Foundry Co., Wheeling, W. Va.; S. P. Bush, Buckeye Steel Castings Co., Columbus, O.; I. W. Frank, United Engineering & Foundry Co., Pittsburgh, and H. J. Koch, Fort Pitt Steel Casting Co., McKeesport, Pa.

Owing to the large number of individual plants in the gray iron and nonferrous branches of the industry, the problem of price revision from the point of contact with these producers will be difficult. A general meeting of gray iron foundrymen, representing more than 4000 shops in the United States, is not possible and the brass manufacturers, 2000 strong, could hardly air their views in open meeting. The situation in the malleable and steel casting industries is different, since the total number of plants in each is limited to slightly more than

200. What method of procedure will be followed in the gray iron and nonferrous branches of the trade has not yet been decided upon, although it is certain that the work will have to be done by representative committees.

At the recent annual meeting of the American Foundrymen's association a war service board, consisting of five members was authorized, which should represent the gray and malleable iron, steel and nonferrous branches of the casting trade. This board has been appointed by Benj. D. Fuller, president of this organization, and is constituted as follows: R. A. Bull, chairman, Duquesne Steel Foundry Co., Pittsburgh; J. C. Haswell, Dayton Malleable Iron Co., Dayton, O.; C. C. Smith, Union Steel Casting Co., Pittsburgh; H. D. Miles, Buffalo Foundry & Machine Co., Buffalo and G. H. Clamer, Ajax Metal Co., Philadelphia. The resolution authorizing this board provided that its membership be representative of the casting industry of the United States, without reference to affiliation with any organization and how well the intent of the resolution has been carried out is indicated by the affiliation of its members with the American Foundrymen's association, National Founders' association, American Institute of Metals, American Malleable Castings association and the Steel Founders' society. Since this board is intended to form a point of contact between the government and the foundry industry of the country in securing castings of proper quality at desired rates of production, at fair prices, etc., many subcommittee undoubtedly will be appointed to represent the various specialized lines of each branch of the casting trade.

Agreed Pig Iron Prices

FOUNDRY GRADES

Silicon, per cent	Gross ton furnace
1.00 to 1.75	32.50
1.75 to 2.25	$33.00
2.25 to 2.75	33.50
2.75 to 3.25	34.50
3.25 to 3.75	35.50

Add $1 for each 0.50 per cent increase in silicon

OTHER FOUNDRY GRADES

Malleable	$33.50
Bessemer	36.30
Basic	33.00
Southern or warm blast charcoal	43.00
Cold blast charcoal	57.00
Lake Superior charcoal, 1.25 Si	35.50
Low phosphorus, copper bearing	50.00
Low phosphorus, copper free	53.00
Silvery iron, 6 per cent Si	40.00
Silvery iron, 8 per cent Si	44.50
Silvery iron, 10 per cent Si	50.00
Bessemer ferrosilicon, 10 per cent Si	55.00

LAKE SUPERIOR CHARCOAL IRON DIFFERENTIALS

Silicon, per cent	
1.50	$36.00
1.75	36.50
2.00	37.00
2.25	37.50
2.50	38.00
2.75	38.50
3.00	39.00

Of further interest to foundrymen is the schedule of differentials for various grades of pig iron figured upon the base price of $33, furnace, for No. 2 foundry and basic iron. This announcement has clarified the situation and is published in full in one of the accompanying tables. It should be noted that the base price for No. 2 foundry iron is $33, furnace, regardless of where the producing plant is located. Therefore, the differentials that have existed on southern iron and which represented the freight rate to the Ohio river have been wiped out entirely. The natural tendency of pig iron purchases, therefore, will be in the direction of lowest freight rate and the distantly located stacks will be the recipients of tonnages only when the nearby furnaces are unable to make deliveries. How this will work out in the great southern iron producing district only can be conjectured, but in periods of limited demand, it is certain that these furnaces will absorb the necessary freight to enable them to compete with northern furnaces.

Throughout the year the scarcity of coke and the high prices that have been prevailing for this fuel, have made foundry operation unusually difficult. While prices were established some time ago on furnace coke at $6 a ton, only recently were agreed prices announced for foundry coke on the basis of $7 a ton, beehive ovens. At the time this is being written, by-product coke quotations have not been decided upon, although it has been recommended that the prices at the various by-products plants be the $7 price for bee-hive coke plus the freight rate from the by-product plant to the nearest bee-hive oven works. Since coke prices have been agreed upon, foundrymen are disturbed over their inability to purchase either spot coke or fuel on contract at established prices. From the standpoint of the cokemaker, it is inadvisable for him to take long-time contracts, particularly in view of the persistent rumors that there may be an upward revision about the first of the year. The scarcity of spot coke is attributed to the car shortage and producers are unable to secure sufficient equipment for their regular trade. The railroad question is, of course, the most vital problem demanding solution in connection with the foundry fuel shortage and it is doubtful if conditions will improve this winter.

Government prices on old material come as a distinct surprise to the trade. The grades on which quotations have been agreed upon include cast iron borings, machine shop turnings, No. 1 railroad wrought and No. 1 heavy melting steel. Furthermore, the maximum prices announced, in every instance are in excess of the quotations prevailing in the various important scrap markets. No. 1 heavy melting steel has been fixed at $30 per ton, consuming point, whereas quotations prior to the announcement of this price did not exceed $28, and at Birmingham this material could be secured as low as $20. No. 1 railroad wrought was fixed at $35 and cast iron borings and machine shop turnings at $20. All of these prices are based on gross tons, f.o.b. consuming point. Basing these prices uniformly on a gross ton schedule is the forerunner of uniform practice along this line and ultimately will lead to the elimination of net prices for old materials, thereby making the sale weight uniform in all markets. In the announcement of pig iron differentials, grades have been eliminated entirely and the schedule is based on the silicon, sulphur, phosphorus and manganese content. This will give added impetus to the purchase of iron on chemical content only and hurries the day when grades and fractures are consigned to the discard. Although the bulk of the pig iron tonnage in recent years has been bought on analysis only, nevertheless, many foundrymen have adhered to the archaic practice of specifying grade and many still place their dependence upon fracture. The only reference to grade in this announcement is to No. 2 foundry iron which should be equivalent in analysis to an iron containing 1.75 to 2.25 per cent silicon and not over 0.05 per cent sulphur. The remainder of the differentials are on analysis basis and the agreed prices will compel purchases to be made on chemical content only.

Recommended Differentials

By agreement between the general committee on steel and steel products of the American Iron and Steel institute, and the war industries board, approved by the President, the base price of No. 2 foundry iron and also of basic iron was fixed at $33 per gross ton, f. o. b. cars, furnace. From these base prices, the sub-committee on pig iron, iron ore and lake transportation has reported to the general committee a list of differentials which the general committee believes is fair and reasonable and in accordance with the usages of the trade, and therefore recommends to the iron industry that the same be adopted to take effect immediately. It is hoped there will be no hesitancy in accepting this recommendation. The list follows:

The grade of No. 2 foundry iron to be equivalent in analysis to:

Silicon	1.75 to 2.25
Sulphur	Not over .05

No. 2 soft southern iron equivalent to No. 2 foundry of same silicon content.

Differentials from the above base price for No. 2 foundry iron to be made for the following changes in specifications:

	Per gross ton
Forge or mill iron	$1.00 under base
Foundry iron running silicon 1.00 to 1.75—	.50 under base
Foundry iron running silicon 2.25 to 2.75—	.50 over base
Foundry iron running silicon 2.75 to 3.25—	1.50 over base

Foundry iron in excess of 3.25 silicon, add $1.00 per gross ton for each ½ per cent of silicon over the price for 3.25 silicon iron.

Manganese, sulphur and phosphorus variations to be adjusted as formerly customary in each district having respect to the base price.

Where iron is sold by fracture, the usual grading prevailing in each district to continue:

Malleable iron	$0.50 per gross ton above base
Bessemer iron	10 per cent per gross ton above base
Basic iron	Base price

CHARCOAL IRON

Southern or warm blast charcoal iron, a maximum of $10.00 per gross ton above base for iron ranging 0.40 to 0.60 phosphorus, and silicon 1.00 to 2.00.

For grades running below these analyses, corresponding reductions as usual to the trade to be made.

Cold blast charcoal iron, a maximum of $22.00 per gross ton above base with customary reductions for lower grades, as recognized by the trade.

Lake Superior iron, $2.50 per gross ton above base for iron averaging 1.25 silicon. Other grades to be adjusted as per the custom of the trade depending upon the silicon, phosphorus and manganese contents of the iron.

All of these charcoal iron differentials to be considered in connection with the base price.

HIGH SILICON OR SILVERY IRON

For iron containing:

6 per cent silicon	$7.00 per gross ton above base
7 per cent silicon	9.00 per gross ton above base
8 per cent silicon	11.50 per gross ton above base
9 per cent silicon	14.00 per gross ton above base
10 per cent silicon	17.00 per gross ton above base

$3.00 per gross ton advance for each 1 per cent silicon for 11 per cent and over.

BESSEMER FERROSILICON

For iron containing:

10 per cent silicon	$22.00 per gross ton above base
11 per cent silicon	25.30 per gross ton above base
12 per cent silicon	28.60 per gross ton above base

LOW PHOSPHORUS IRON

Iron containing phosphorus and sulphur not exceeding 0.04, and silicon not exceeding 2 per cent:

For copper bearing iron	$17.00 per gross ton above base
For copper free iron	20.00 per gross ton above base

A sliding scale of $1.50 per gross ton advance for each reduction in phosphorus of 0.005 per cent below 0.04 and $1.75 per gross ton advance for each 1 per cent of silicon in excess of 2 per cent.

Probably the most disturbing factor that has been introduced into the situation is the implied suggestion of the possibility of the abrogation of existing contracts. In a questionaire sent to the manufacturers of iron and steel by the federal trade commission, inquiry was made for opinions on this subject. While it may seem to be the proper course of procedure to the foundryman who is covered far into the future for pig iron at prices greatly in excess of those agreed upon, nevertheless he must not overlook the fact that the abrogation of contracts will be far-reaching in its effect and will apply equally to the casting orders on his books based on high market quotations, and these would have to be revised downward if this action were taken. On the other hand, the foundryman who still has a large tonnage of low priced iron coming to him on uncompleted contracts hardly would care to have these cancelled and the agreed prices substituted therefor.

Regardless of the foregoing considerations which might be characterized as selfish, a moral question of great magnitude is involved. If our government sanctions a practice that has been held illegal by our courts and which has consistently been frowned upon by the trade, what will the future hold in store for the American business man in his contractural relations? The violation of the treaty with Belgium is the most noted contract-breaking episode in history and the adoption of a contract abrogation policy would be our favorable endorsement of this heinous offense. In the iron and steel industry, other than the casting trade, 42 agreed price schedules already have been issued and the American Iron and Steel institute committee will issue at least 30 more.

Furnace for Melting Copper-Zinc Alloys

New Induction Unit Recently Developed by Philadelphia Company, Designed Primarily for Utilization in Rolling Mills

THE Ajax Metal Co., Philadelphia, which is building the Ajax-Wyatt electric furnace for melting copper-zinc alloys has designed the furnace principally with a view toward its utilization in rolling mills. Like the Schneider furnace, the Ajax-Wyatt is of the closed-channel induction type, so that when it is operating, a pool of molten metal exerts an hydraulic pressure upon that metal in the closed channel. This channel constitutes the secondary loop of the current path. Heat is generated in the channel because of the restricted cross-section and the consequently higher resistance. Motor effect in causing circulation is set up at the acute angle of the V-shaped channel, which is located at the lower extremity of the furnace and communicates with the main body of the furnace through the ends of the diverging arms of the V.

Consisting of the body, the channel portion and a transformer, the furnace unit is built to be rotated about trunnions. The furnace body, which is adapted to receive a pool of molten metal and melt the pieces of metal down into it, consists of a lined steel jacket fitted with a spout. In this type of construction, the transformer is interposed between the body of the furnace and the casing within which the lower part of the channel is built. In this way a shell type of transformer is built into the unit and forms part of the frame of the complete furnace. This, it is claimed, reduces the number of metal parts, avoids interruptions of the magnetic circuit and reduces heat losses.

The transformer is of the single-phase shell type. The channel is rectangular in cross-section and at its extremity forms an acute angle. At the point where the channel communicates with the pool, acute angles are avoided. The channel ends meet the pool in a generally vertical direction at the outer edges of the pool and on opposite sides, thus enabling a stirring action to be exerted upon the liquid in the pool when circulation through the channel is set up. When electric currents traverse fluid conductors and flow in opposite directions, electro-dynamic forces are set up in the connectors in directions perpendicular to the lengths of the conductors and these tend to repel each other. If the conductors are not parallel, corresponding hydrodynamic forces tending to produce motion of the fluid parallel to the conductor are set up. This phenomenon is what is known as *motor effect,* and in the Ajax-Wyatt electric furnace causes motion of the molten metal and hence circulation. Although *Joule effect* and *pinch effect* also are present, *motor effect* is said to be of prime importance in starting and maintaining circulation of the metal.

Rapid charging of this type of furnace incurs no possibility of the metal solidifying in the secondary channels, or in the lower portion of the pool, it is said, the only precaution necessary being to exercise care in preventing the bridging of the charge. The furnace may be tightly sealed, as the forces which act in the channel are asserted to have the ability to carry the heated metal upward and thus bring it in contact with the metal to be melted.

At present the furnace is made in two sizes with ratings of 30 and 60 kilowatts, respectively, and designed to operate with single-phase, 60-cycle, 220-volt current. The power factor of the 30-kilowatt furnace is 85 per cent and of the 60-kilowatt furnace, 72 per cent. The load factor approaches 100 per cent. For starting, the smaller furnace requires a 75-pound starting charge while the larger unit requires a charge of 125 pounds. The smaller unit pours 300 pounds in one heat, while the large unit pours 600 pounds. Melting rates of the two furnaces are 6½ to 9 pounds per kilowatt-hour for the smaller unit and 7½ to 11 pounds per kilowatt-hour for the larger unit; the lower figures were obtained when a 70-30 alloy was melted in the form of bulky turnings, while the higher were obtained with extrusion metal consisting of a 60-40 alloy—the usual rolling mill mixture. The temperature of the cast metal averages about 2000 degrees Fahr.

This furnace, in its present stage of development, is intended only for melting copper-zinc alloys carrying not more than 3 per cent of lead. When once started, it is necessary to keep the furnace in continuous opera-

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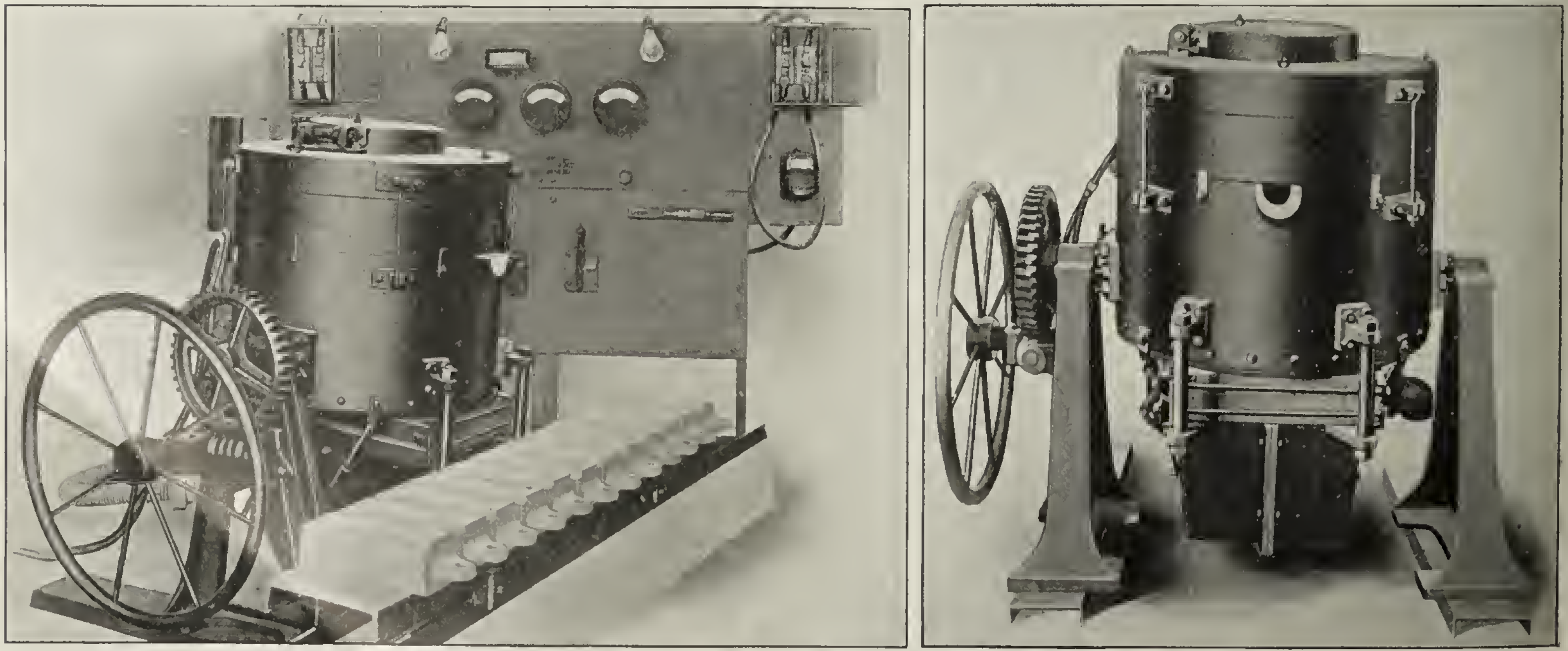

TWO VIEWS OF INDUCTION FURNACE DEVELOPED BY AJAX METAL CO., PHILADELPHIA

Organizing a Malleable Iron Foundry in 90 Days

How Richmond, Ind., Foundrymen Overcame Difficulties Imposed by an Inadequate Supply of Labor and Poor Delivery of Building Materials

THIS is a true story. If it proves to be stranger than fiction, it is because American ingenuity has been compelled to go to great lengths in order to solve the complex problems of present-day industrial activity. The scene is Richmond, Ind., and the principal characters are four men who decided in 1916 to operate a malleable foundry.

In arriving at this decision, the four men took into account the unusual conditions prevailing at the time. It was clearly evident that the unusual demand for castings was far in excess of the existing productive capacity of foundries. The same activities which stimulated the demand for castings had the effect of slowing-up deliveries of other kinds of material. This feature of the situation made it necessary to devise ways and means of securing equipment in the shortest possible time and if the proprietors were to enjoy the benefits of the existing high markets, they could ill afford to lose time in getting the new foundry under way.

Utilize Tractor Plant

Therefore, when the question of building was considered, they eliminated the possibility of erecting a new foundry, and promptly decided to purchase a plant already built which would be suitable for their purpose. After investigating a number of factory buildings, they chose one which had formerly been used for making agricultural tractors. This plant was situated near the business district of Richmond, Ind., on the main line of the Pennsylvania railroad. It consisted essentially af a large brick and wood building of mill construction, having a high roof, and was unusually well lighted by large areas of sash in the side walls and cupola. Most of the sash in the cupola were pivoted, thereby affording good ventilation. This large building appeared to fulfill the requirements of a model molding room for a malleable foundry.

The deal by which the old tractor plant was acquired was negotiated Nov. 1, 1916. Two of the four men, who had been associated with one of the largest manufacturers of malleable castings in the United States, immediately assumed the task of putting the building in shape for foundry purposes. They found it necessary to tear up the floor in the main building, to install an automatic sprinkler system throughout the plant, to make a number of alterations in the roof construction of the main building, and to build a structure adjacent to this building to house the annealing ovens and core room.

In general, it was not necessary to make any radical changes in the large building which was to be used for the foundry proper. As shown in Fig. 1, which is a view of part of the molding floor, it was only necessary to install the wood stalls separating the molding floors. These are clearly shown in the illustration. Each molding floor was equipped with a hand squeezer made by the B. & B. Mfg. Co., Indianapolis, and snap flasks made by the Diamond Clamp & Flask Co., Richmond, Ind. The entire plant was then piped for compressed air and water. The air lines were supplied with air at a pressure of from 60 to 65 pounds per square inch by a Chicago Pneumatic Tool Co. air compressor situated in the southeast corner of the building.

The 10-Ton Furnaces

It was found necessary to make slight alterations in the building to accommodate the melting equipment. Profiting by their experience with the large manufacturer of malleable castings, the two men designed a type of 10-ton air furnace best adapted to their purpose. One of these units is shown in Fig. 2. Each furnace is essentially of the approved design commonly employed in malleable foundries, but is of unusually substantial construction. Brickwork is encased in heavy castings held in place by vertical steel rails anchored in the ground. The blast enters the furnace through five nozzles connected to a blast pipe which passes underneath the molding floor, thereby overcoming the objection of having an overhead pipe obstructing the headway over the furnace. A centrifugal blower manufactured by the Clarage Fan Co., Kalamazoo, Mich.,

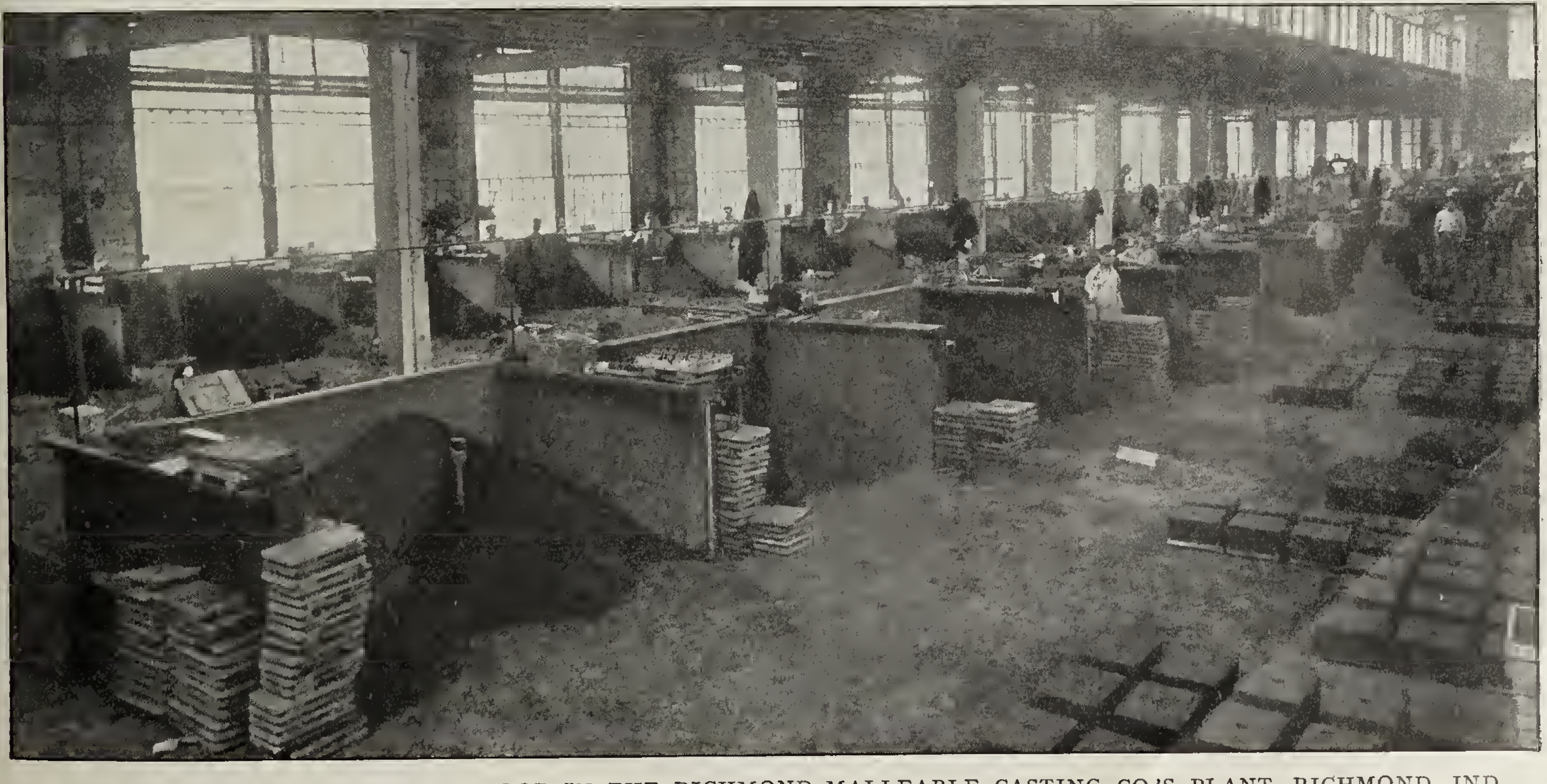

FIG. 1—VIEW OF THE MOLDING FLOOR IN THE RICHMOND MALLEABLE CASTING CO.'S PLANT, RICHMOND, IND.

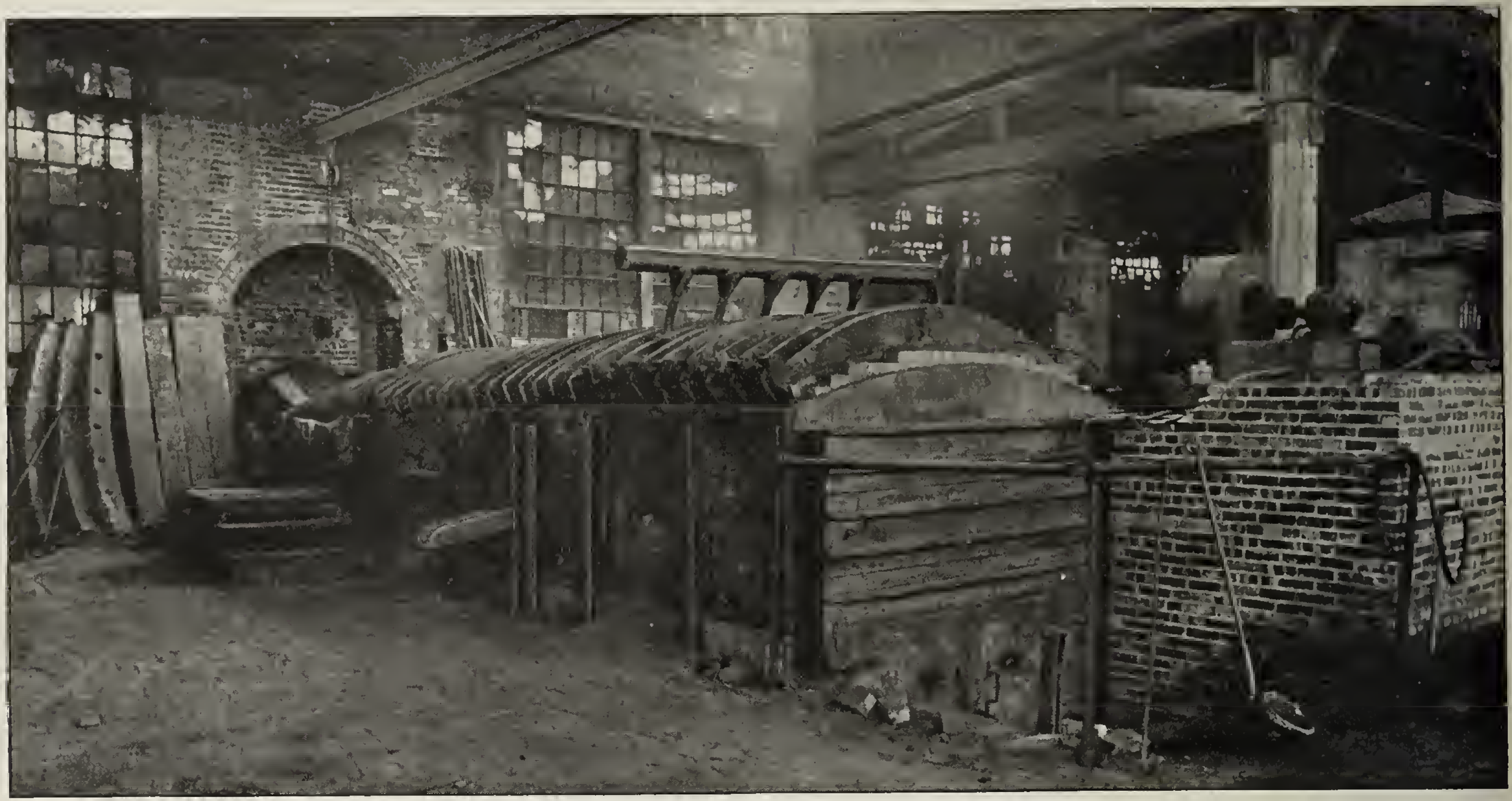

FIG. 2—ONE OF THE TWO 10-TON AIR FURNACES—THE BLAST PIPE EXTENDS UNDERGROUND FROM BLOWER TO FURNACE

provides blast for each 10-ton furnace. These fans are driven by individual 10-horsepower, 60-cycle, 3-phase motors, made by the General Electric Co., Schenectady, N. Y.

With the exception of the two double bungs, each bung is made of a single re-inforcing forging, a single row of refractory fire brick, and a single adjustment device of the lever type. The double bungs which are removed for charging the furnace, consist of two of the ordinary single bungs bolted together at three places. The center bolt serves as a catch for the hook of a 1-ton chain hoist made by the Wright Mfg. Co., Lisbon, O., which traverses an I-beam suspended from the roof trusses. This arrangement is clearly shown in the illustration. The rectangular brick structure at the right serves as a bin for the coal which is used for fuel in the furnaces. The ashpan is shown in the foreground. The furnace is charged at about 7 o'clock in the morning and at 12:30, and pouring is commenced at about 11 o'clock in the morning and about 4:30 in the afternoon. The metal is tapped from each side of the furnace and is carried direct to the molds in small distributing ladles. The pour-back platform is shown at the left of Fig. 2. Skimming doors are provided on either side, as indicated in the above illustration.

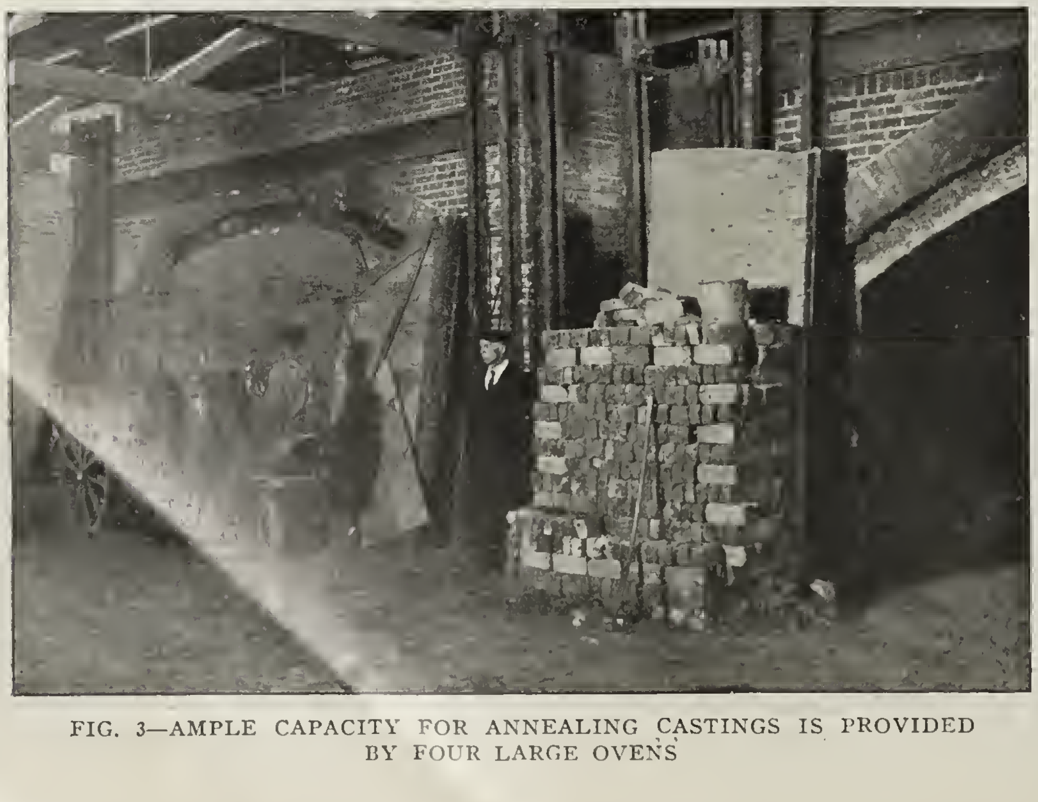

FIG. 3—AMPLE CAPACITY FOR ANNEALING CASTINGS IS PROVIDED BY FOUR LARGE OVENS

Unusually serious difficulties were encountered in attempting to build the addition in the foundry to house the annealing ovens. It was found that steel could not be secured in less than six or seven months, and when local lumber dealers and contractors were approached on the subject of providing large timbers on short notice, they replied that it was necessary to order the lumber from Alabama and that it could not be secured in less than six months. Rather than be balked by these obstacles, the president of the newly-formed company, accompanied by a gang of 10 men went into the woods near Richmond and there they cut and shaped the timbers which were used as roof trusses for the new building. This expedient saved many months in the period required for constructing the new building, and was one of the factors which enabled the builders to complete construction work promptly. The heavy roof truss construction is clearly shown in Fig. 3, which is a view in the annealing room.

Routing of Castings

The core room, hard iron cleaning room, annealing ovens, soft iron cleaning room and shipping department are in a large room in the new building paralleling the molding floor. As shown in Fig. 7, which is a plan of the foundry, this arrangement provides for a steady movement of the castings in a straight line as they progress through the various stages of manufacture.

In the hard iron cleaning room, the castings are cleaned by a combination sand-blast and tumbling barrel made by the MacLeod Co., Cincinnati, and tum-

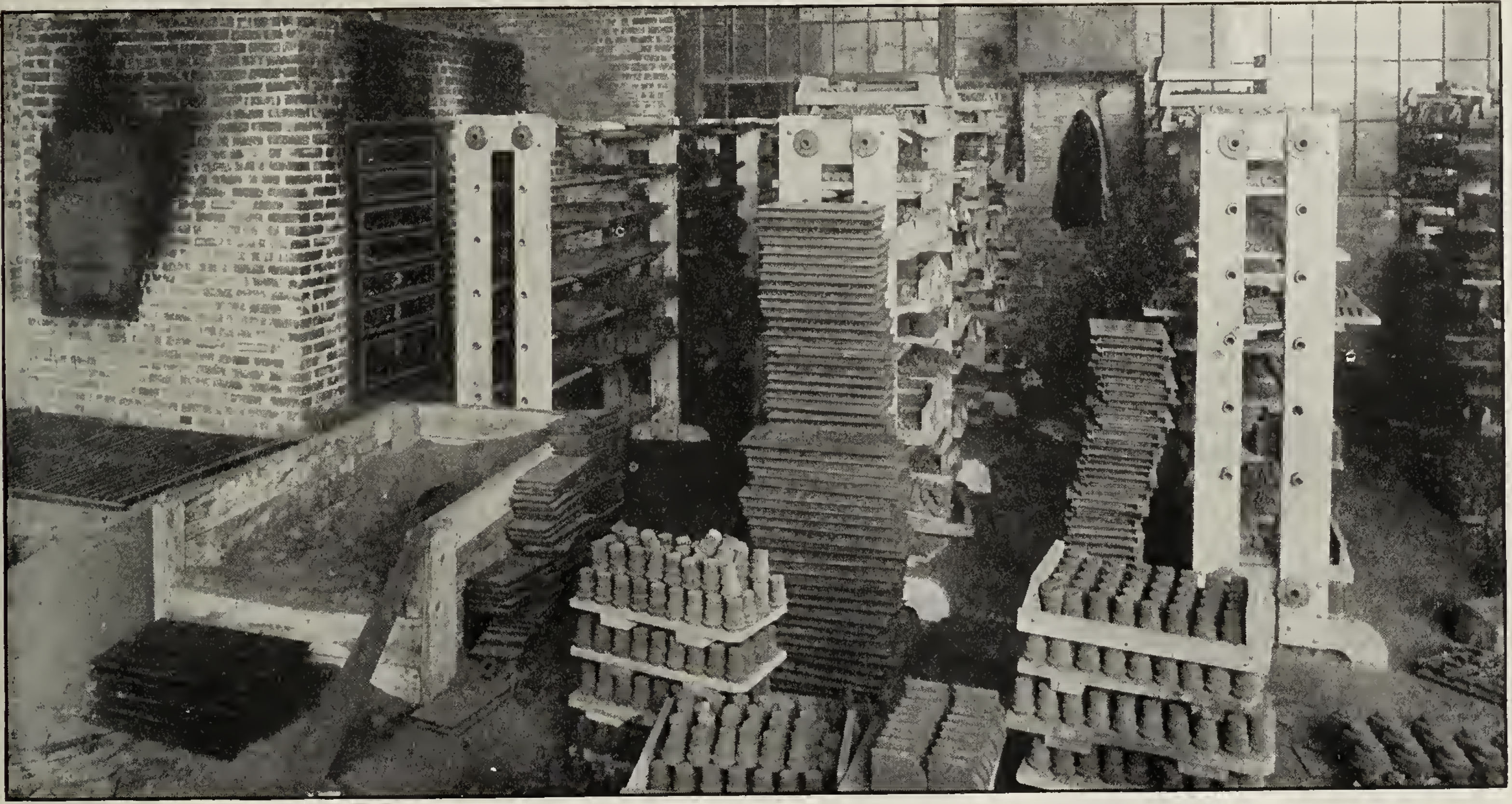

FIG. 4—VIEW IN THE CORE ROOM SHOWING ECONOMICALLY CONSTRUCTED RACKS AND CORE OVENS

bling barrels made by the W. W. Sly Mfg. Co., Cleveland. The dust from this equipment is collected in a MacLeod dust arrestor shown in Fig. 6. Castings which have been annealed are cleaned by the sand-blast barrels and tumblers all made by the W. W. Sly Mfg. Co., Cleveland.

The Annealing Ovens

The annealing ovens are of the type shown in Fig. 3. The four ovens are coal-fired from fire boxes at the rear. Hot gases from over the grates enter the annealing chamber at the top and circulate downwardly over the castings and are exhausted through adjustable vents near the floor. The doors are made in four sections, each of which consists of a double row of bricks securely packed in heavily braced channel iron frames. Pending the arrival of a crane which will operate on the I-beam shown in Fig. 3, it has only been possible to move the two smaller sections of the doors into place. This has necessitated building-up the additional opening with common brick and tearing this out after each heat. When the new crane is in place any one of the four sections of the door can be handled easily. The charging boxes containing the castings are handled by the charger shown in the illustration. As indicated in Fig. 7, the core room is in the northeast corner of the building. Coremakers' benches are situated along the east wall while the core oven and the core storage racks occupy the west section of the room. The core racks have proved of unusual value in handling the light cores used in the foundry. They consist of two standards of wood, drilled for 1-inch pipes which serve as racks for core trays.

The arrangement of the various departments of the foundry is ideal for the economical handling of material. As shown in Fig. 7, the raw materials consisting of coal, pig iron and scrap enter the foundry proper at the west. Here the materials charged into the furnace are placed on wood trucks, as shown in Fig. 5. It will be noted in this illustration that a few of the trucks are numbered on the side. These numbers, which in one case is 385 and in the other 392, refer to the number of pounds of a certain material which should be placed on the truck. The truck, with its approximate weight of charging material, is placed on a platform scale made by the Fairbanks Co., New York, and is then hauled to the furnaces for charging. It is expected that in a short time these trucks will be handled to and from the storage yard and the furnaces by an electric storage battery truck. The castings in the cleaning room are handled in the steel barrels shown in Fig. 6. These barrels are made by Ohio Mfg. Co., Painesville, O.

Sorting the castings after they have been cleaned in the annealed iron cleaning room, is a difficult problem because many of the pieces are of unusually small dimensions. A recent order filled in the foundry called for 50 tons of small chain links. As each of these links

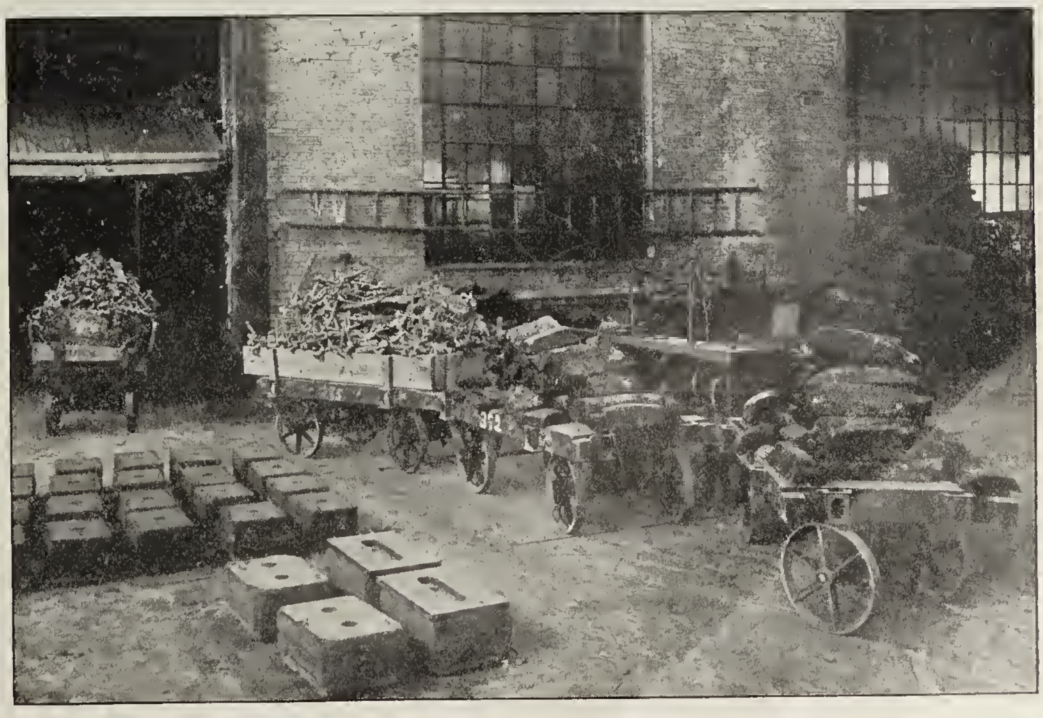

FIG. 5—CHARGES FOR THE AIR FURNACES ARE CARRIED FROM THE STORAGE YARD TO TRUCKS

weighed 0.04 pound, there were 2,500,000 pieces in this single order. To facilitate the sorting of the castings, an inspection and sorting bench has been provided in the shipping room. The castings are taken from boxes on either of two sorting benches and are thrown into receiving boxes which are placed in a row between the benches. All out-going castings are weighed on floor scales made by the Howe Scale Co., New York.

Pay Molders' House Rent

The installation of equipment and machinery, although offering many difficulties, was accomplished in an unusually short time. The most serious stumbling block to the rapid formation of an efficient organization was the scarcity of labor. Long before the plant was ready for operation, it became necessary to scour the country for good molders. After considerable effort in this direction, it was found advisable to offer an inducement to molders who would become steady workers in the new plant. Accordingly, men were brought to Richmond from other labor centers with the understanding that houses would be provided for them and their families and that the rent would be paid by the company. This plan proved so successful in the earlier stages, that the company has adopted it in a general way. The fact that the company pays the rent is not allowed to have any bearing on the amount of wages paid the men. This policy, together with the knowledge that as soon as the man leaves the employ of the company his rent automatically stops, has been an important factor in building up a permanent and reliable labor organization.

In addition to the inducement that is offered because of the rent-paying proposition and because of the unusually good working conditions obtaining in the foundry, the proprietors endeavor to make the wages attractive to workers. Molders who come to the Richmond shop for work and are accepted are put to work on a day-work basis. An accurate record is kept of the production of molds for each day, and as soon as a man acquires the skill and speed necessary to turn out a sufficient number of molds to make more money at piece work than he is already making at day work, he is placed on a piece-work basis. There is no tendency on the part of the owners of the foundry to interfere in any way with the amount of money a molder can make. It is felt that the extra production warrants the highest amount that a man can possibly make.

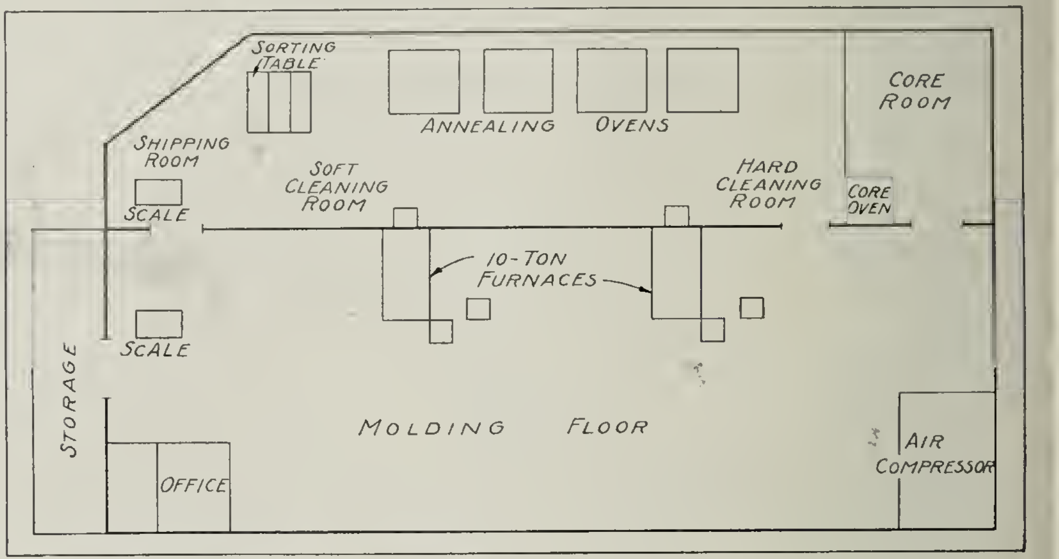

FIG. 7—PLAN VIEW OF THE RICHMOND MALLEABLE CASTING CO. FOUNDRY

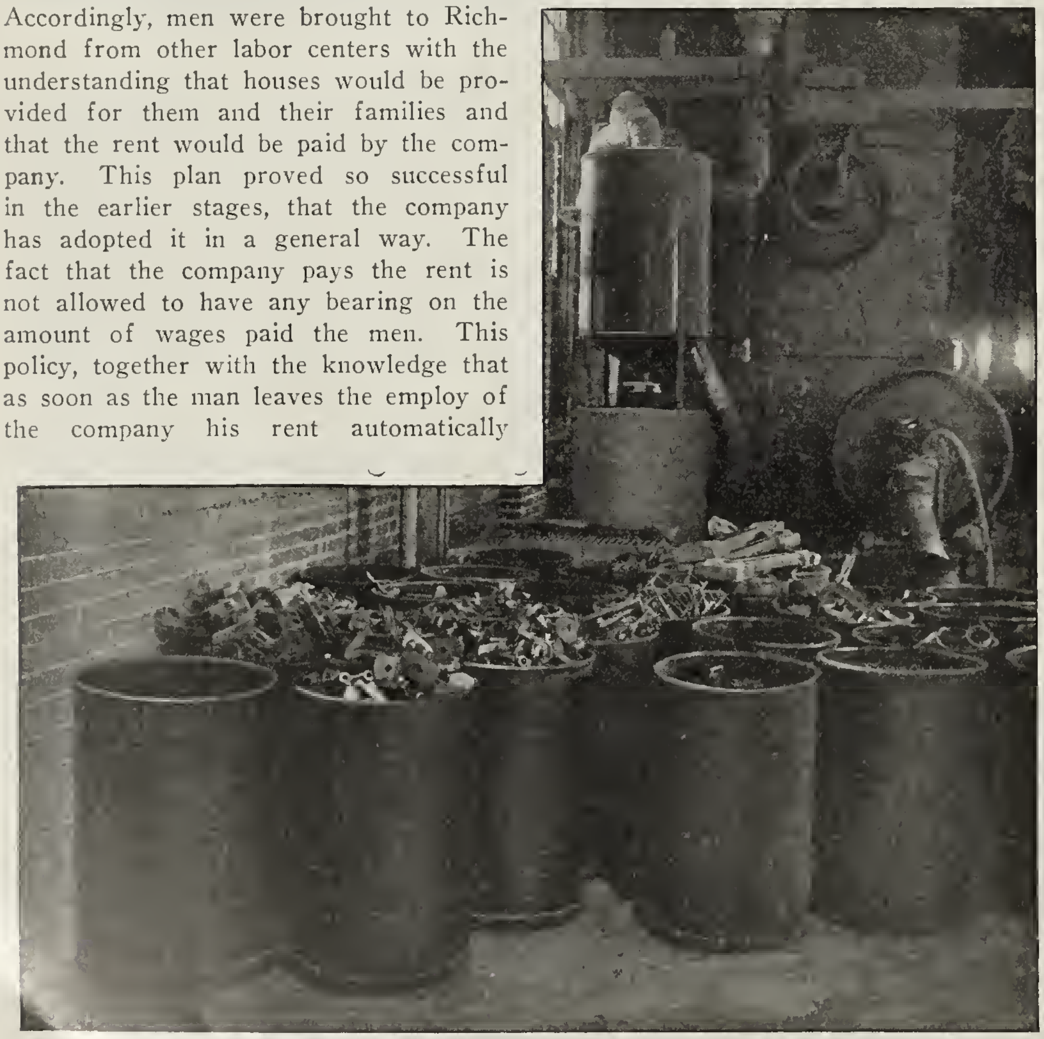

FIG. 6—CASTINGS ARE HANDLED IN THE CLEANING ROOM IN STEEL BINS

Despite the offer of good wages, it is almost impossible to secure experienced molders. For that reason, many of the men who are doing molders' work are novices. To counteract the inexperience of many of the workmen, the molding operations have been reduced to the simplest form. Most of the work is performed by means of match-plates and vibrators used in connection with snap flasks. No great amount of molding skill is required to operate these devices, and it has been found that inexperienced men can be trained in from six to eight weeks to turn out unusually good work with this equipment. Most of the castings made in this foundry consist of light and heavy hardware parts, wrenches, clamps, parts for hay-carriers, automobile castings and parts for lawn-mowers.

Pours First Iron in 90 Days

In spite of the difficulties encountered in perfecting this organization and installing the equipment the plant, which was acquired Nov. 1, 1916, was ready for operation Jan. 31, this year, and on this day the first heat was successfully poured. This performance, which in reality means that a complete malleable foundry was put in operation in 90 days, was due principally to determination of the men interested to avoid and overcome the obstacles imposed by present day deliveries of material.

The details of the organization were worked out by W. J. Blackmore, secretary and general manager, and C. D. Calvelade, superintendent. J. M. Lontz, president, and H. R. Lontz, vice president and treasurer, were also responsible for overcoming many of the difficulties encountered.

The Detroit agency of the Whiting Foundry Equipment Co., Harvey, Ill., is now in charge of R. E. Prussing, 318 Penobscot building. Mr. Prussing has been connected with the Whiting Foundry Equipment Co. for the past 10 years.

Employment of Female Labor in the Foundry

Only by Elevating Coremaking to an Attractive Occupation Can Foundrymen Hope to Hold the Services of Efficient Women Workers

By W L Churchill

THE present and growing shortage of male help brings up the problem of substituting female labor therefor. Casting plants are especially hard hit as the nature of most foundry occupations is such as to employ only vigorous, robust men, many of whom are being drafted and the more attractive employment of other lines is tempting others away.

In the molding department of the foundry there is little opportunity for the utilization of female help with present facilities and arrangements. However, for making small cores, women have come to stay as the work is especially adapted to female labor. Many foundries already have arranged their small coremaking on a basis to utilize female help, but only a small number have done it in a manner to make it an attractive occupation for the average type of woman worker.

There is nothing inherent in the work of making small cores that is disagreeable, unsanitary, or unduly laborious for women. If cores were food products and made in "Sunshine Biscuit" bakeries where all the smoke and dust are kept out of the department where women are employed and where they are provided with every comfort and convenience to make their work attractive, coremaking would have as many and as desirable types of applicants as the more modern fancy biscuit and confectionary plants.

It is possible to make the occupation of coremaking an attractive one to a good class of women and the foundry that elevates this occupation to such a basis reaps a harvest of reduced costs, lessened spoilage, accurate work and an increased volume of output. It is not a difficult problem to arrange a core room satisfactorily, as it involves only the selection of a proper location permitting the making of small cores where the smoke, dust, noise and generally disagreeable atmosphere of the average foundry can be eliminated.

Such a place usually is found for patternmaking, but the coremakers too frequently are compelled to work in an atmosphere of stifling smoke and gases, with surroundings of dirt and caked grime that can only induce low human standards to tolerate.

Simply partitioning off a corner of a smoky, dirty foundry or coremaking department is far from solving the problems properly, although many foundries get away with such makeshifts and do fairly well with women coremakers employed in such parodies of desirable work rooms. All too often these rooms become a hanging out place for an element of the male labor about the foundry, which destroys all discipline and makes for indifferent and low output.

Simply replacing male coremakers will not get the results that are possible, as the whole subject needs to be studied with an understanding of how best to utilize women workers.

First, they must have an absolutely wholesome atmosphere to work in. This is impossible when cores are baked in the same room in which they are made.

Good Working Conditions Essential

Second, the women coremakers must be separated from the male workers and should be assisted and instructed by as few men as possible and these should be of a type selected for their general desirability and understanding of the class of people they are serving.

Properly arranged, a coremaking department should have such privacy for its women employes that they do not meet the other employes except the few that help and instruct them.

They should have separate, private entrances and should begin work after the other foundry departments and should leave at an earlier hour.

An ideal solution of this problem was effected by the writer in 1913. This has stood the test of time and illustrates the possibilities of properly directed effort.

The foundry in which this department was installed, constantly was short of molders and had introduced female coremakers to some extent, thereby liberating a few men from the core department to be utilized as molders. No attempt was made to change the coreroom conditions in any way; the foundry superintendent had merely obtained such women as he could attract with good wages to work in the smoky, noisy, filthy, department, and other than threatening with discharge anyone caught annoying these women, little was done to make their occupation desirable or safe. They were obliged to get the sand mixtures, core wires, plates, etc.; they carried the cores to the ovens, even in some instances doing the baking.

The plant had a one-story warehouse for the storage of surplus castings and as the policy of making surpluses was discontinued, the building was available for other purposes. The warehouse had a cement floor and plenty of windows. It was equipped with a heating plant, painted white, and was fitted up with a generous cloak and wash room. A combined rest and lunch room was provided and a type of coremaking bench was designed that permitted the coremakers to work while seated on comfortable, backed stools.

The benches were so placed that the women coremakers did not have to leave their benches or stools. The finished cores were placed by them on take-off tables from which they were removed by core-carriers who delivered them on rubber-tired spring buggies to the corebaking room which not only was separated from the coremaking room, but was so thoroughly ventilated that little if any smoke or odor from the ovens reached the coremakers.

The coremaking tables had slide chutes projecting over the service aisles into which the core sand was supplied from tote pans by the man employed to supply such mixtures. The men also distributed plates, core wires and other supplies as needed, and as the room was kept scrupulously clean and the girls supplied with caps and uniform overall aprons, it resembled a business college more than a typical coremaking department.

Separated by the cloak room from the rest of the coremaking department, the tubs and jolt machines for the heavier cores made by male coremakers were placed next to the corebaking and sand-mixing department. This brought the biggest sand users nearest to the sand supply and ovens and also effected a separation of the women coremakers that enabled them to conduct their work in such privacy that brought them in contact with only a foreman and two young men who supplied sand and took away the finished work. A private entrance led direct to the street, and with a time clock for their sole use and by having them report for work later and dismissed earlier than the other foundry employes, their privacy was complete.

When first instituted, the 10 or a dozen women already employed in the former core room were transferred and were requested to help get more girls to fill up the new core tables. Naturally they brought other women of their acquaintance, chiefly non-English speaking foreigners and much to the surprise of the management an indignation meeting was held by the girls employed in the packing department connected with the plant and a protest was submitted calling attention to the evident partiality being shown to foreigners in giving them better work, in better surroundings, and better conditions than the natives enjoyed in the other-manufacturing branches.

Cost of Cores Lowered

As a result of this careful arrangement a desirable type of women workers sought positions in the coremaking department, and although piece work was temporarily abolished, the core costs made an immediate and substantial drop, quality was greatly improved, production was accelerated and increased and a number of men workers were obtained for other foundry occupations.

The type of tables designed especially for the women, which provided means of supplying sand and other materials without interruption of work, was a large factor in the success of female labor in this foundry. Placing the department where there was no occasion for other employes to enter it and where the general foundry atmosphere was entirely absent, removed all objection to employment in such a department by anyone suited to this class of work.

There are few foundries making small, cored castings in large quantities, that cannot profitably undertake to put this work on a basis to be done by women, and the more attractive they make it the greater will be their reward. Also, it is not without influence in elevating the tone of the entire establishment, even with a complete separation of the department from contact with the other employes during business hours. The fact that women acquaintances find desirable occupations in a foundry is apt to make a young man who is considering a trade to look into the possibilities of the foundry when otherwise he would not give it a thought.

How the Sales Engineer Views the Foundry

By H R Atwater

MUCH has been written in reference to the lack of business methods in the foundry industry as a whole, and to the lack of appreciation of the importance of adopting progressive modern methods and labor-saving devices. Undoubtedly this criticism has been well merited, but it is also true that much has been done toward bringing the foundry up to a productive point comparing favorably with other lines of manufacture.

It would not be an exaggeration to say that for the past five years the method of producing castings has been revolutionized. The number of pieces produced in plants per man unit has been increased in some instances 500 to 1000 per cent. This has been due principally to the installation of molding machines, means for bringing iron to the floors, sand handling devices and equipment for handling the molds from the machines.

Never before in the history of the foundry industry have the demands for greater output been so insistent as at this time. Labor is constantly demanding a larger share of the profits of the industry, and I am sure that every right-minded man wants to see the rewards of labor increased. However, labor rewards cannot be increased by simply forcing up prices on one another, in order to get this increased wage. If the increase is to be permanent and such as can be met by the manufacturer, the production must be speeded up—where we are now getting one mold we must get at least three from no greater increase in the labor unit. To do this means better equipment and more knowledge of its use and possibilities. Those foundries that are operating entirely under old hand methods are being called upon to pay a higher wage than can possibly be afforded, and in many plants the hand molder is almost an impossibility when comparing the wages demanded to the production he is willing to turn out. This condition has forced many foundrymen to install not only molding machine equipment, but methods for handling iron in pouring off the work, and in fact any equipment that will save labor and reduce the number of men required.

Opposition to Molding Machines

It is generally stated as a fact that molders do not take kindly to molding machines, or in fact to the use of any other modern device that may be placed in the foundry. In many plants this has been demonstrated to be true, although the writer knows of plants where union molders in good standing work on molding machines and turn out a production in some cases 1000 per cent greater than was done when the work was made by hand. Moreover, the wage earned is more than double any union scale in force in any foundry in the country. In stating this fact it is not intended to open up a discussion as to which is the better method—that of trying to work molders on machines or breaking in laborers to operate them—but rather to bring up the question before the foundry industry and to ask if it is looking far enough ahead with sufficient vision to meet the requirements. Is it taking the opportunity to organize the plants and to equip them so that their production will not be cut down? This is the important thing whether operating with molders or so-called handy men. In these days when men are so scarce and the need of increased production is great proper means must be found to work both molders and handy men to their capacity.

It is the writer's opinion that the success or failure of modern equipment and particularly molding machines in any given plant depends on the state of mind. Unless complete co-operation is given from the head of the plant down through the superintendent, foreman, patternmaker or others in charge, no very considerable success will be obtained from either the working of molders on the machines or the use of laborers. The thought and co-operation necessary to make a success must be such as to make a careful analysis of the cost of production on given patterns, an understanding of the proper rigging of the patterns and the kind of flasks to be used, and the price basis established on a quantity production that will largely increase the wage of

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This paper was presented at the Boston meeting of the American Foundrymen's Association. The author, H. R. Atwater, is sales engineer, Osborn Mfg. Co., Cleveland.

THE FOUNDRY DATA SHEET, DECEMBER, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

FORMULAS FOR THE BRASS FOUNDRYMAN

NAMES AND COMPOSITION OF MISCELLANEOUS ALLOYS

Damar Bronze

This alloy is used as a bearing metal, the composition being approximately as follows:

	Per Cent
Copper	76.50
Tin	11.00
Lead	12.50

Graney Bronze

This alloy also is used for making bearings. Its composition follows:

	Per Cent
Copper	75.50
Tin	9.50
Lead	15.00

Die-Casting Alloys (Bronze)

ANALYSIS NO. 1

	Per Cent
Copper	79.26
Zinc	15.24
Aluminum	4.78
Manganese	0.16
Iron	0.56
Tin	Trace

ANALYSIS NO. 2

	Per Cent
Copper	79.42
Zinc	16.00
Aluminum	3.85
Manganese	0.13
Iron	0.60

ANALYSIS NO. 3

	Per Cent
Copper	89.88
Aluminum	10.06
Manganese	0.06

THE FOUNDRY, DATA SHEET NO. 247, DECEMBER, 1917

FORMULAS FOR THE BRASS FOUNDRYMAN

NAMES AND COMPOSITION OF MISCELLANEOUS ALLOYS

Electrode Bronze

	Per Cent
Copper	87.39
Tin	7.25
Manganese	0.18
Zinc	4.95

This bronze was used as the material of construction of bronze, water-cooled electrode holders for ferro silicon furnaces. It is a good tough metal, suitable for many purposes where such an alloy is specified. The manganese content is somewhat higher than necessary. This should be represented by the addition of 0.5 per cent of 30 per cent manganese copper as the maximum.

Kochlin's Bearing Alloy

	Per Cent
Copper	90
Tin	10

This alloy is usually deoxidized with phosphorus, using 0.25 per cent of phosphor copper.

Lafond's Heavy Friction Metal

	Per Cent
Copper	83.00
Tin	15.00
Lead	0.50
Zinc	1.50

Harrington Bronze

	Per Cent
Copper	57.00
Zinc	41.00
Tin	1.00
Iron	0.75
Aluminum	0.25

This alloy somewhat resembles manganese bronze, but is deficient in elongation. It may be used for unimportant castings where cheap metal is specified.

THE FOUNDRY, DATA SHEET NO. 248, DECEMBER, 1917

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

the operator as well as bring a largely increased production to the plant. It is not possible to get a largely increased production unless the operators are to share in this increase.

I have come in contact with owners of plants where a few machines have been installed, whose sole concern seemed to be how much they could cut the molding price on all patterns that they put on machines, and the idea uppermost appeared to be that the price of the equipment should be returned to them in the first few weeks or months of operation. Naturally no large production is ever obtained in plants where this policy is pursued. Unless the men in immediate charge of foundry production first make a careful study of the possibilities of the equipment which has been installed as to the amount of work it is capable of turning out and establishes a production that is somewhere near the capacity of the equipment, they are not in position to fix a price or a wage that will insure the machines being operated at their capacity. If the equipment installed is capable of earning 100 per cent on the investment, the responsibility of realizing this must be shared in a liberal way with the men who are asked to operate

A Word to the Foundry Foreman

It would seem at this point that a word regarding the foundry foreman would be worth considering. We cannot hold a man responsible for what he does not know and it is a certainty that most of the failures to get satisfactory production from machine equipment, come from ignorance both as to the possibilities of the equipment, the amount of production that should be obtained and the wages that should be paid to get the production. There are foundries now operating in which this matter has been investigated so thoroughly and with such a broad vision that the matter of production and wages is causing them no trouble. It is not probable that these problems will bother the owners of these foundries greatly in the future, for they have builded well and they will keep well to the front, whatever demands may be made upon them. They will be in a position to properly meet all the varying changes, as they come up.

It would seem that the foundry industry as a whole could make no better investment than at every opportunity to have their foundry foremen, superintendents and those in immediate charge of production, visit modern plants, study equipment on exhibition at the different foundry shows, and encourage them to think along lines of conducting the foundries on business principles. The foregoing remarks cannot be applied to all foundries, owing to conditions that exist as to buildings, room for installing equipment, etc., which will not permit of operating modern equipment to the maximum production, but it is the writer's belief that if plants now operating under these handicaps are to continue in the production of castings and to meet competition, these conditions will have to be changed.

In these days it is the labor unit that must be considered, and it usually follows that men will go where the most modern equipment is furnished and where they are required to perform the least amount of labor at the highest wages. It is the writer's observation that power-operated machines are the ones most favored. Hand-operated machines are not far enough removed from hard labor and the so-called skill of the molder to insure the best results. As the hand molders cannot compete with machine production even when operated by hand, neither can the hand-operated machine compare favorably with the power machine in production or saving in hard labor. It naturally follows that the hope of the foundry in the future must be in installing power equipment and in teaching laborers to successfully operate machines that will produce the largest possible output and net the operator more money than he can possibly earn at any other work. Devices also must be furnished him that will make the labor less hard than it has been. Only in this way can the industry hold its men and turn out an equitable production.

A Troublesome Gating Problem

By R R Clarke

THE trouble was like Banquo's ghost, it would not down. It came about because a surface-attaching gate deposited its metal directly against and over a thin and necessarily weak green sand projection, in and running entirely around the central part of the mold. It was a ring projection of green sand in the mold and practically impossible to miss by the surface gate. We had as possibilities either the dry sand core projection or the horn gate. We chose the horn gate. The patterns were plate mounted for snap flask molding on a pneumatic squeezer machine, three patterns exhausting the intaking capacity of the flask. These patterns made blank gear wheel castings in which accuracy was high. The first time we saw the castings made, over 75 per cent of them were lost from sand-washing. Before discarding the surface gate, we tried practically every trick of the trade in order to retain it. Forced to the departure we placed core prints on the pattern, the prints accounting for horn gates in the green sand back of the core. By this method, we delivered the metal to the bottom of the mold and calculated that it would rise placidly over this ring projection and do no harm. In this we were sadly mistaken as the trial mold readily demonstrated. The trouble was that the metal was dammed up in the central portion of the mold and exerted a pressure beyond the resisting power of the sand projection to withstand. This sand consequently gave way before the metal had a chance to overflow into the outer circle.

We kicked the trial castings into a corner where no one would see them and resolved to do something. We remembered that in the nostrils of all correctly put together humans is a little tube leading back to the inner chambers of the hearing mechanism. Hold your nostrils tight, blow hard and you will discover this little tube a part of your own anatomy. Its object is to admit air into the inner cavity in order to protect the delicate tympanum or eardrum against the strong atmospheric pressure from the outside; in short, to equalize that pressure. We decided to imitate, first concluding to part the green sand projection just enough to allow the metal to flow through it and into the outside simultaneously with the inside. But this would make a hard chipping job so we sought another remedy by which all metal channels would locate on the outside casting surface. To realize this objective we bored a ¼-inch hole in the gate core in line with the gate of the gate core and at that point in the casting where the metal would enter the outside ring simultaneously with its rising to the lower edge of the green sand projection on the inside. Our reasonings were that the metal would flow down the horn gate past the hole in the core and rise to the same level in the gate and casting until this core opening was reached when it would flow into the outside ring through this opening and back the green sand projection against the inside metal pressure. Results amply substantiated the argument and we are realizing the very best of castings.

We made the evil self-correcting and fool-proof with no perceptible exaction on the machine molder's time. This we consider one of the first line principles of successful machine molding.

How to Solve a Foundry Lighting Problem

By Following a Number of the Fundamental Principles of Illumination, a Practical Foundryman Can Plan an Efficient Lighting System

By C E Clewell

TO ILLUSTRATE some of the practical phases of foundry lighting, it is the purpose of this article to describe briefly, the methods employed in planning the lighting in a large foundry in northwestern Pennsylvania where, after a number of tests, it was found desirable to install flaming-carbon arc lamps according to a design worked out by the writer. This particular case is not selected on account of the type of lamp used but to explain the principles involved. It will be noted throughout the article that the methods of calculation apply equally well to other possible types of lamps such as the tungsten, mazda and the mercury vapor lamps.

Fig. 2 shows in plan and elevation the general arrangement of the foundry in question. Like many other industrial plants, this building has a low overhead clearance, making it necessary to mount the lamps not much more than 18 feet above the floor. To anyone attempting for the first time to plan out such an arrangement of lamps for producing a satisfactory lighting effect, the difficulty of telling just how many lamps to use will come up as one of the first questions to settle.

It is almost as important, however, to determine whether the direction in which the light is given off by the lamps is such that most of the illumination will reach the mold surfaces. It is not enough that the horizontal surfaces shall be sufficiently lighted, since it is also necessary to light perpendicular surfaces. It is, therefore, frequently necessary to determine whether a sufficiently large side component of illumination on the working surfaces is going to result from lamps mounted overhead, as shown in Fig. 2.

Why Certain Lamps are Selected

We will consider that a floor plan like that in Fig. 1 is to be lighted by lamps of a certain type mounted overhead. For example, the management of the foundry may have selected a certain type of lamp because of its apparent ability to penetrate through the smoke and dust so often present in the air, or for some other cause not directly connected with the way in which the light is distributed about the lamp. Assuming that a flaming-carbon arc lamp has been selected for some such reason, let us proceed to check up this type of lamp as applied to the conditions of floor area and ceiling height in Fig. 2.

From the lamp manufacturer we can usually find how the light is distributed about the type of lamp chosen, as illustrated in Fig. 1. This diagram simply means that by actual measurement the lamp sends out about 1,075 candle-power in a vertically downward direction; about 1,320 candle-power at 10 degrees to the vertical, and so on. The use of this curve will be explained later. If the designer of the installation has data available on other installations of the same type of lamp, he may have at hand a figure telling hom how many watts (units of electrical energy) per square foot of floor area the lamps consume as usually employed for foundry work. If such a figure is at hand, he then need only multiply the total floor area by the watts per square foot usually employed, to obtain the total watts required by all of the lamps, and this figure then divided by the watts consumed per lamp, gives the number of lamps necessary to light the foundry to an intensity of illumination approxi-

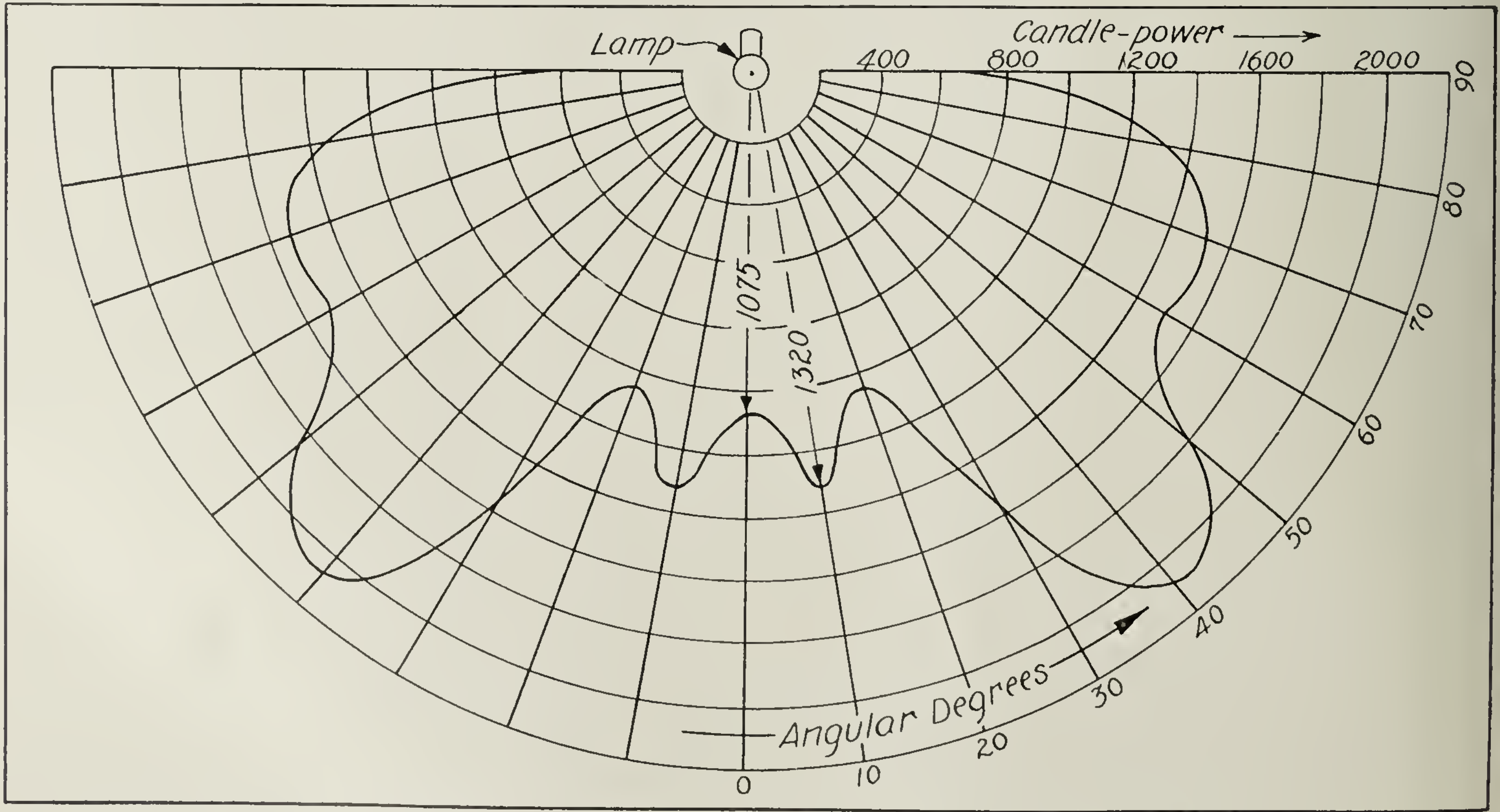

FIG. 1—DISTRIBUTION CURVE OF AN ARC LAMP—THE CANDLE POWER VALUES ARE MEASURED RADIALLY FROM THE UPPER CENTRAL PORTION OF THE DIAGRAM

The author of this article is assistant professor of electrical engineering, University of Pennsylvania, Philadelphia, and author of "Factory Lighting," published by the McGraw-Hill Book Co.

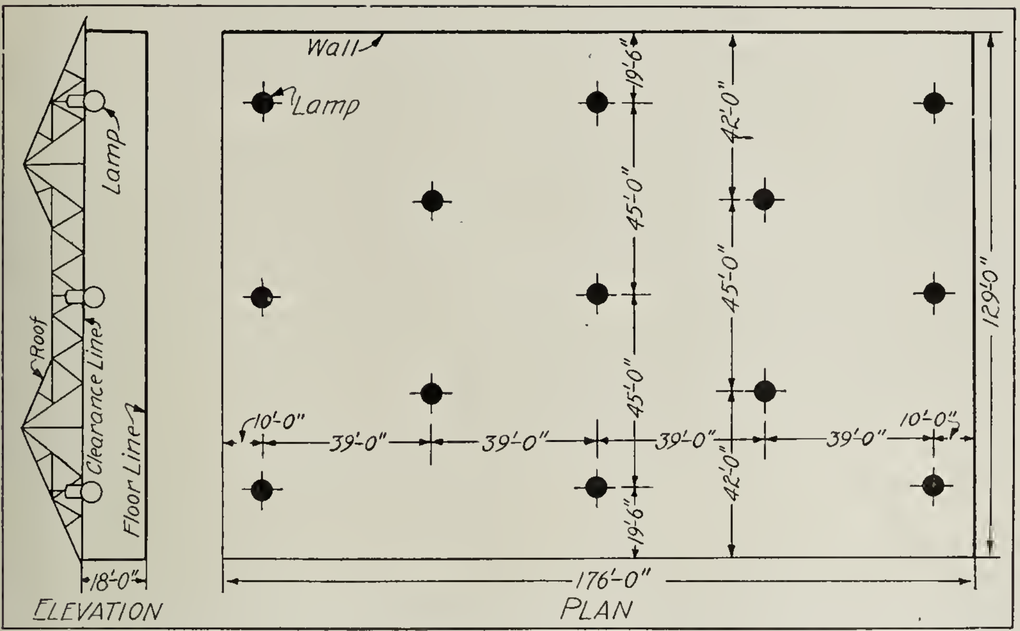

FIG. 2—CONVENTIONAL PLAN AND ELEVATION OF A LARGE FOUNDRY SHOWING ONE WAY IN WHICH TO ARRANGE 13 LARGE ARC LAMPS OVERHEAD

mately equal to that of the previous installaton. Thus we may write the following simple relation:

$$N = \frac{WA}{W}$$

where *N* stands for the number of lamps required; *w* for the watts per square foot necessary to light the work based on other similar cases; *A* for the floor area in square feet; and *W* for the watts consumed per lamp of the type chosen. Great care must be exercised in handling this calculation to make sure that the "watts per square foot" value used corresponds with the type of lamp to be used. Thus, if tungsten or mazda lamps are to be used instead of arc lamps, *A* watts per square foot value suitable for mercury vapor lamps or for arc lamps cannot necessarily be employed for the mazda lamps, and the reverse is also true.

Locate Lamps Symmetrically

In the foregoing case, after determining the number of lamps necessary for an overhead arrangement it usually is best to locate these lamps on a drawing in a symmetrical manner over the ceiling area somewhat as indicated in Fig. 2. It will often be found desirable to check such an arrangement by means of the distribution curve of the proposed lamp, first, to determine whether the illumination on the work is uniform and secondly, to find whether it is sufficient in quantity.

This check may be made by means of the relations shown in Fig. 3. Thus, if the illumination intensity at a point directly below a lamp is to be found, look at the distribution curve, Fig. 1, and observe the value of the light in candle-power given off vertically downward. This, divided by the square of the distance between the lamp and the working surface, gives us the intensity (in foot-candles) at this point due to this one lamp. The foot-candle is used here as the unit of illumination intensity. Thus, the illumination intensity on a surface produced by a one candle-power lamp located at a distance of one foot from the surface, is equal to one foot-candle. At two feet from the surface, the lamp will produce one fourth of a foot-candle, and so on. In other words, the intensity varies closely as the inverse square of the distance between the surface and the lamp.

We must now determine how much intensity is contributed to this same point by all the other lamps, by duplicating this calculation for each lamp which is near enough to the point to contribute any light to it. For all the other lamps, except the one directly above the point on the floor in question, it is necessary to multiply the quotient of candle-power and the square of the distance between the lamp and the point *by the cosine of the angle between the line joining the lamp and the point and the vertical line,* so as to give the vertically downward component of the illumination at the point under consideration.

This is made clear by reference to Fig. 3, in which the vertically downward intensity at any point other than the point directly below a lamp, is found by the equation:

$$\text{Intensity} = \frac{\text{c. p.} \times \cos (b)}{d^2}$$

It will be noted that the value of *d* is different for every point chosen. Hence a more convenient form in which to use this relation is the following modified form:

$$\text{Intensity} = \frac{\text{c. p.} \times \cos^3 (b)}{h^2}$$

In this equation, c. p. stands for the candle-power, *b* for the angle, and *h* for the mounting height of the lamp above the working plane. Note that *h* has the same value for any point that may be taken on the working plane, so that it is more convenient to use *h* than *d* in spite of the fact that by so doing the third power of the cosine must be introduced.

Refer to State Codes

To check uniformity and intensity of the illumination at representative points over the floor area, it is necessary to duplicate the rather long set of calculations just outlined for a number of points over the working plane. After carrying out this work, the results indicate whether the vertically downward illumination is uniform and also its value, and the latter should then be checked against the intensity called for by the state industrial lighting code for foundry work, or if no such code is in

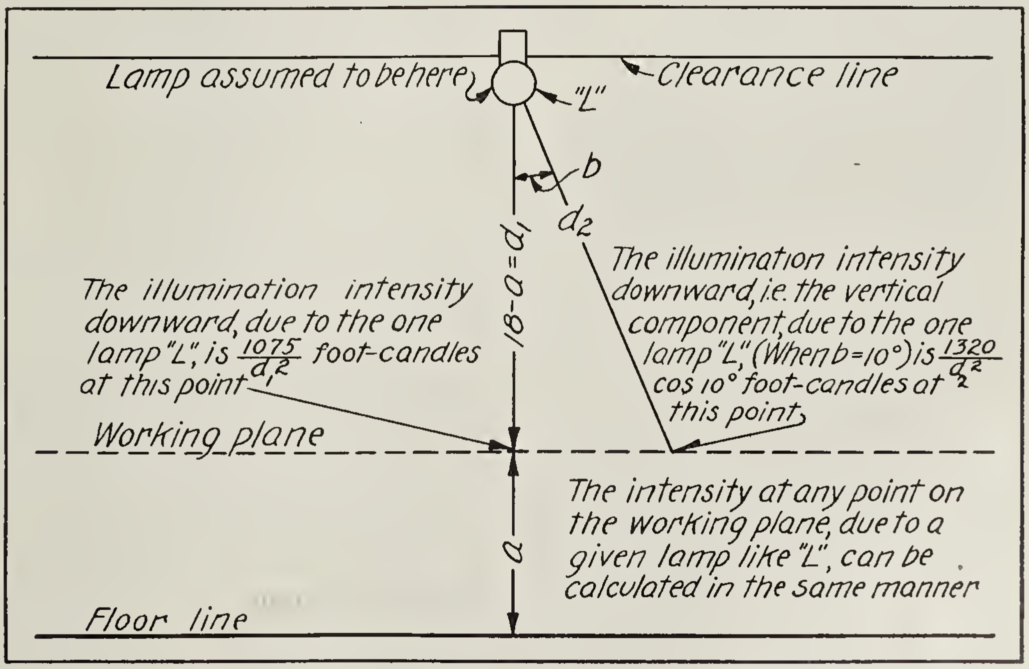
Lamp assumed to be here
"L"
Clearance line
b
d_2
$18'-0" = d_1$
The illumination intensity downward, due to the one lamp "L", is $\frac{1075}{d_1^2}$ foot-candles at this point
The illumination intensity downward, i.e. the vertical component, due to the one lamp "L", (When b=10°) is $\frac{1320}{d_2^2}$ cos 10° foot-candles at this point
Working plane
a
The intensity at any point on the working plane, due to a given lamp like "L", can be calculated in the same manner
Floor line

FIG. 3—USE THE METHOD INDICATED IN THIS DIAGRAM WHEN CHECKING FOR UNIFORMITY AND INTENSITY—THIS DIAGRAM IS TO BE USED IN CONJUNCTION WITH FIG. 1

force, against some authority. To illustrate, the factory lighting codes in the states of Pennsylvania and New Jersey call for a minimum of 1.25 foot-candles for foundry work, and recommend as desirable from 1.25 to 2.50 foot-candles for such work. The illumination on vertical surfaces can be checked up in like manner *by using the sine* instead of the cosine of the angle shown in Fig. 3.

Enough has probably been indicated to show that these calculations require considerable care and dexterity, and many cases are likely to be of sufficient importance to call for expert service in advance of making the installation. Furthermore, it is always possible to check up such an installation of lamps after its completion by actual measurements, in order to ascertain whether or not the results based on the calculations have turned out as expected, or whether some slight change is required to make the system meet all the requirements.

If the designer of the system has no figures available at the outset giving the watts per square foot of floor area for suitable lighting, he may be forced to locate the lamps on a drawing of the floor area in a symmetrical manner., the number of lamps chosen being determined purely by guess-work at the start. The check on uniformity and intensity previously described should then be carried out and if the quantity of illumination on the working plane is too low, the lamps should be rearranged on the drawing and a new check made. This cut-and-try method should be continued until the intensity and uniformity of illumination conform to standard practice.

Practices of the Designer

Of course, a laborious cut-and-try method to this extent would hardly be necessary after a designer has gone through several typical experiences, for when a new location comes up, he can refer back to the calculations covering a somewhat similar case with which he has had experience, and probably soon arrive at a close figure for the number of lamps to select. This discussion shows one reason why a lighting expert is usually in a better position to tell how a system should be laid out than a man who attacks such a case for the first time.

The foregoing suggestions will give the practical foundryman an idea of a few of the points involved in planning a lighting system. There are many other points which have a bearing on the problem, but it is perhaps best in a brief article like this to discuss the problem from one angle only, since the introduction of too many factors might tend to confusion.

It is hoped, however, that this brief recital of some of the factors involved in foundry lighting, may not only prove of interest, but may tend to make those who use light in their work, more careful of the way they subject their eyes to unshaded bright lamps and other similar harmful effects. In other words, this article, in addition to its practical suggestions, has endeavored to emphasize the importance of giving special care to the lighting problem, which frequently does not receive the degree of attention its importance warrants.

Labor Appreciates the Human Element

By J F Kent

WHETHER his skin is white, black, red or yellow, man is a social animal. You can work a mule from one year's end to another and as long as you keep his stomach full he is satisfied. A man is different. On Saturday night he looks for something besides a pay envelope. You can't treat him as an animal or a machine and successfully get away with it for any length of time. He is a man and you are a man, and in that kinship lies the secret of good or bad relations.

Recognition of that kinship goes by many names, the most popular probably being "Welfare Work". No matter what you call it, however, it is the same thing; it exists in any business where men work for other men, and in any state or country. In the foundry of the American Cast Iron Pipe Co., Birmingham, Ala., we have endeavored to give this relationship proper recognition. When I first went to Alabama, a good many years ago, I heard men with experience say that negro labor was not dependable. and that the "only way to handle a negro was to take a pick handle or some similar persuasive implement and knock him in the head about twice a week". Today three-fourths of the laborers in our shop are negroes. They are as dependable as any ordinary class of labor, and in making them so the pick handle method never has been used.

Encouraging Habits of Cleanliness

At no kind of work will a man get as dirty, perhaps, as in a big pipe foundry. Therefore, one of our first steps was the construction of a brick bath-house large enough to accommodate all of the employes. In the 12 months from Oct. 1, 1915, to Sept. 30, 1916, white employes took 25,753 baths and negro employes 166,477. When our men go to and from work they are dressed in good clothes, with white collars and polished shoes. Few would imagine that they worked in a pipe foundry. The indirect value of these baths upon the negroes is beyond estimation. As anyone might surmise, whose olfactory nerves ever came within business distance of a thoroughbred southern negro on a warm day in June, the race is not particularly addicted to the bathing habit. The baths our men get at the shop, therefore, not only keep them clean, but communicate the infection to their families and friends, with the result that the waterworks company has a growing consumption as far as the negroes are concerned.

We installed a medical department, which, from a small beginning, has developed until today we have a thoroughly equipped operating room, consultation room for both races, dental parlors for both races and a drug dispensary. This establishment is conducted by two doctors; one a high class surgeon and general practitioner, and the other a physician; a white trained nurse; two negro trained nurses; a dentist, and a consulting board composed of several of the leading specialists of our city. Employes pay for this service at the rate of 50 cents a month for single men and $1 a month for married men For the married men, all members of his family are entitled to the services of the department. Needless to say, this work is very far from self-supporting. Our motive in assessing the dues being to impress upon the employe some degree of its importance and prevent abuse of the system.

Every new man now employed must stand a thorough physical examination, and if the doctors find any condition present which might endanger the health or safety of other employes the applicant is refused employment. Injured men are given first-aid treatment at the dispensary, and when seriously injured are taken to one of the city hospitals. Some years ago we had one or two cases of tubercu-

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A paper presented at the Boston meeting of the American Foundrymen's Association. The author, J. F. Kent, is general manager of the American Cast Iron Pipe Co., Birmingham, Alabama.

losis, and we constructed out-door houses for the afflicted men on top of a mountain near the plant, where their recovery has been complete.

We have constructed a 3-story Young Men's Christian Association building. In charge of the association's activities are two trained secretaries, one who remains at the plant and one who spends his time visiting the homes of the employes, where he advises them about many of the phases of their daily life, especially regarding thrift, sanitation, disease prevention, cookery, education, religion and similar subjects. This work, of course, is confined to the negroes.

A mutual benefit association is in operation which has a thousand members out of a possible 1200, and which pays out monthly in sick, death and accident benefits an average of about $500. A few stastistics afford a quick way of covering the ground. They include a period of 12 months as follows:

	White	Negro
Men's bible classes	600	1,733
Boys' bible classes	564	.....
Sunday school	3,754	547
Socials for men only	545	1,315
Moving picture shows	4,564	16,030
Educational classes	1,035	3,537
Library books used	839	40
Shower baths	25,753	166,477
Number served at restaurant (mixed)	201,604	
Number served in dining room	7,154	
Amount deposited in savings bank	$1,514.71	
Taught to read and write	13	
Attendance at athletic games, players	3,953	
Attendance at athletic games, spectators	12,030	
Medical, surgical and special cases treated at medical dispensary	21,697	

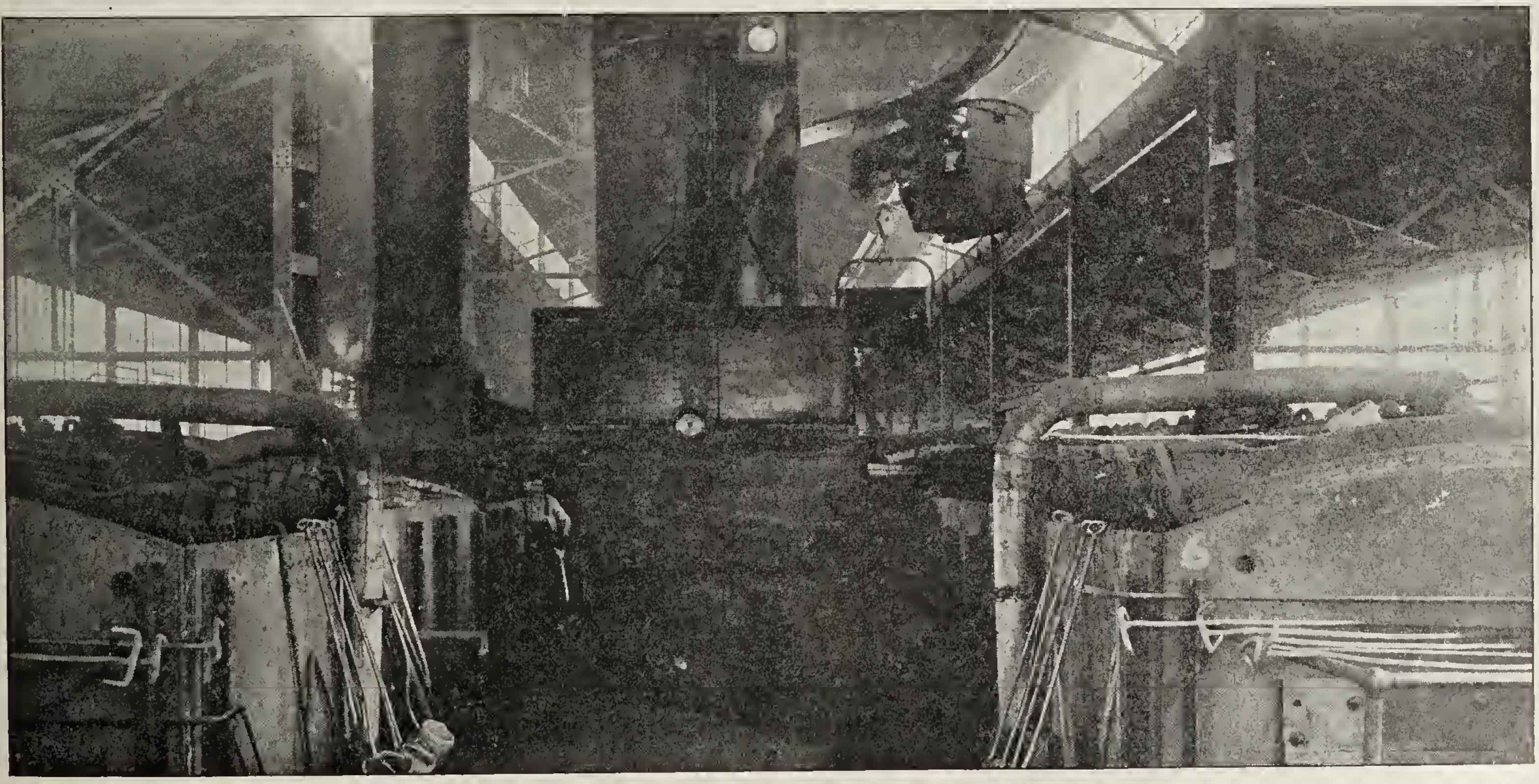
There are a few other phases of this welfare work which I might mention incidentally, such as a week's vacation given the shop last summer on full pay; a suggestion box plan by which every employe is given an opportunity to make suggestions for the more economical or safe operation of the plant and for which cash prizes are awarded; a cash bonus of from 5 to 10 per cent on each employe's salary for the year 1916 as high or higher wages as are paid by any other employer of labor in the district; financing of homes for white employes and the construction of a model negro village with nice homes for rental to the negro employes; active and aggressive safety work in every department.

While this, of necessity, is little more than a mere catalog of what we are trying to do, I believe it should give you a more or less vivid picture of what we are using instead of the pick handle. We believe, and endeavor to make our employes realize, that their success is dependent upon ours, and ours upon theirs. As the chairman of our board of directors puts it, we strive to see "how much, not how little, wages we can pay; how easy, not how difficult, we can make our work".

Boilers Reclaim Melting Furnace Heat

By C D Townsend

AFTER considerable investigation of the various kinds of boilers, including horizontal, marine, and others, an upright water-tube boiler finally was selected as the equipment best suited for the utilization of waste heat from melting furnaces. The fact that the floor space required was comparatively small was an important factor in determining the choice. The next question was size, and the results of deliberations with the engineers were that it was preferable to have the boiler over-size rather than under-size. A 250-horsepower boiler was estimated to be of sufficient size, considering the grate area of the furnace; but because of what might be called a superheated gas after it has passed over a bath of molten metal, and because of its velocity, greater capacity was deemed advisable and a 400-horsepower boiler was finally decided upon as being adequate for any emergency. In order to utilize the waste gases from the furnace and get constant results from the boiler, and also to keep the boiler under steam pressure all the time, it is best to have two furnaces and an auxiliary fire-box connected with the boiler. By running the furnaces one at a time during the day, a full head of steam can be kept on the boiler, except for intervals during the time of charging the furnaces, and for



WASTE-HEAT BOILER SHOWING AUXILIARY FIRE BOX AND MELTING FURNACES

The author of this paper, which was presented at the Boston meeting of the American Foundrymen's association, is general manager, Danville Malleable Iron Co., Danville, Illinois.

a short period while the cold stock is being thoroughly heated. This takes care of all firing necessary on the boiler for at least 9 hours of the day. During the balance of the day the boiler can be kept under pressure with a slight amount of fire through the auxiliary fire-box. One furnace is operated while the other is being repaired; and then the order is reversed.

Regulate Temperature by Draft Fan

The temperature control in the furnace and the efficiency of the boiler can be very materially aided by the addition of an induced-draft fan in the base of the stack. By operating this fan with a variable-speed motor or steam engine, the furnace draft can be regulated as desired. The use of the fan tends to hasten the time of melting and, due to the velocity with which the gases are drawn through the boiler, the efficiency is increased. The temperature in the base of this stack is approximately 800 degrees Fahr., and the temperature at the back bridge-wall of the furnace is about 2500 degrees Fahr. These figures show that a large volume of waste gas is used in making steam. With this equipment approximately 246,000 pounds of water are evaporated per day. In the auxiliary fire-box, from one to three tons of coal per day are used, according to requirements.

As before stated, connecting two 20-ton furnaces to the auxiliary fire-box of the boiler insures constant operation while furnace repairs are being made. With the use of the auxiliary fire-box, the boiler is kept under pressure during the night and at other periods while the furnaces are not in operation. By keeping the boiler constantly under pressure and heat, the danger of breakdowns caused by contraction and expansion is minimized.

The boiler should be set as close as possible to the back bridge-wall of each furnace in order to utilize all the waste gas possible. This can be accomplished by setting the furnaces parallel to each other or at right angles to the boiler, which arrangement should be figured out to best suit local conditions. To take care of the tremendous amount of gases that pass through the boiler during the period of melting, it is advisable to set the boiler eccentric with the casing, leaving the greatest area on the front or steaming side of the boiler so that the extremely hot gases have a chance to rush up the front side and become effective nearer the top of the boiler. On the other hand, if the boiler tubes are set close to the casing, the intense gases and impinging flames will do most of their work on the tubes near the bottom of the boiler.

The water supply for a waste-heat boiler should be absolutely assured. It is best to have two independent sources of supply, since it is obvious that, if for any reason the water supply should fail, a heavy loss and probable calamity would result. To further insure continuous operation, all piping and valves should be extra heavy and erected with a great deal of care. In fact, expense should not be considered too largely in making the water and steam connections to a waste-heat boiler.

In the writer's opinion the most desirable use of a waste-heat boiler is when the full steam capacity of the boiler can be utilized. This can best be accomplished by using the waste-heat boiler in conjunction with a battery of hand-fired boilers, the steam pressure to be equalized and balanced by their use. In this way the waste-heat boiler serves as an auxiliary or a fluctuating source of steam supply to a boiler plant. If the steam line of a waste-heat boiler is connected directly into the steam log or header of the regular power-plant boilers, the hand-fired boilers can be run to the entire accommodation of the waste-heat boiler; that is, the hand-fired boilers can pick up the power load and carry it until the waste-heat boiler begins to come into service. Then the hand-fired boilers can be gradually slacked off and the fires banked, taking the full steam supply from the waste-heat boiler and thereby acting as a safety valve or regulator for it. It is apparent that in a waste-heat boiler there is no such thing as control of the steam supply. If all the steam that is made cannot be used, it has to be wasted.

A Word About the Care of the Boiler

A waste-heat boiler requires constant attention. It is most important to remember that the boiler is a fire-eater, and that to keep it on the ground the water supply must be *positive* and intelligently supplied. The boiler should be washed down and the tubes inspected for defects at least every three weeks, and the flues should be turbined, if necessary, not less than every six weeks. It is very important that treated water should be used to minimize the collection of boiler scale. Soot should be blown off the tubes at least three times a day. In fact, every possible care should be exercised to keep the tubes clean.

A 400-horsepower boiler connected with a 20-ton furnace operating at capacity will produce steam at the full capacity or a little in excess of the actual capacity of the boiler after the iron has been reduced to a semi-fluid state or say for 8 to 9 hours per day. There is no effect noticeable on the furnace operation and, in fact, the furnaces are operated entirely in disregard to the boiler connection. The fuel ratios do not change; neither do the furnace firing operations. In fact, the entire furnace conditions are absolutely normal, and should proceed in utter disregard of the boiler.

Another method of utilizing waste-heat is to set a boiler of convenient size alongside the neck of the furnace. With a variable speed induced-draft fan at the base of the boiler stack, sufficient gas could be diverted into the boiler to heat water or produce steam for various shop purposes, such as toilet uses, heating, etc.

Preparing Sand for Steel Foundry Work

Question:—We would like to obtain a good facing sand mixture for both green and dry sand molds for cast steel, and also a formula for a steel mold wash.

Answer:—In steel molding practice a sand is required that is sufficiently refractory to prevent fusing when in contact with the molten metal. Silica sand has been found to be satisfactory and its color largely is an index of its quality. The whiter the sand the purer, and consequently it is better adapted for making steel castings than a brown sand which is more fusible, although considerations of economy occasionally cause the latter to be preferred. Since silica sand is without bond, it is necessary to supply one artificially which is accomplished by mixing the sand with fire clay and molasses water and milling it in a pan mill to thoroughly incorporate these ingredients. A mixture of 10 parts silica sand and 1 part of fire clay, mixed dry with a sufficient amount of molasses water to temper the sand to molding consistency, will be found to be satisfactory. The sand can be varied in toughness by increasing or reducing the fire clay as desired until a mixture is obtained that may be considered satisfactory for the work to be molded. For a wash, use silica flour mixed with molasses water which should be sprayed or brushed onto the molds for skin dry and dry sand work. However, for green sand work, washes cannot be used.

T. H. Watson & Co., Ltd., Sheffield, Eng., announces the installation of a number of Greaves-Etchells electric furnaces in British plants. Kryn & Lahy, Letchworth, are now operating a 5-ton unit in making steel for munitions. A 3-ton furnace has been installed by the Tyne Electric Steel Castings Co. Thomas Andrews & Co., Sheffield, recently placed in operation a 1½-ton furnace designed to produce nickel chrome vanadium airplane and motor steels.

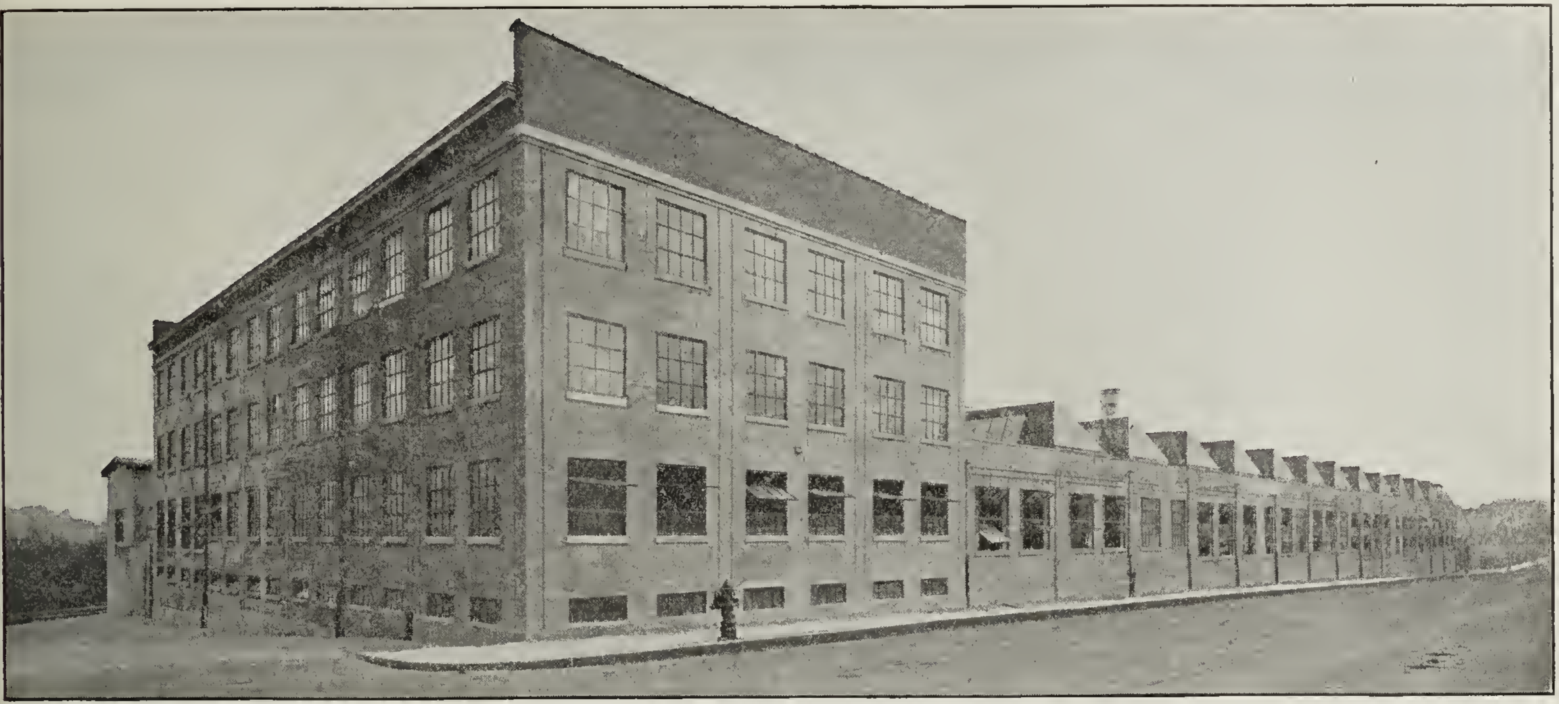


Fig. 1—Exterior View of the Lunkenheimer Foundry—The 3-story Building in the Foreground is Used for Pattern Storage

Cincinnati Foundry for Making Special Castings

Description of Equipment of New Foundry of the Lunkenheimer Co., Designed for Gray Iron, Malleable and Semisteel Castings

IN THE manufacture of engineering specialties, including various types of valves for high pressure steam and hydraulic work, it is essential that the materials be of high quality and great uniformity. This makes it necessary for the foundry which produces castings for these articles to be provided with facilities for making various kinds of mixtures in addition to the standard gray iron metal of which the majority of the castings are made. Therefore, when the Lunkenheimer Co., Cincinnati, decided to erect a new foundry, considerable attention was devoted to planning a shop in which gray iron, malleable iron and various forms of semisteel could be made. The plans materialized in a well-equipped and exceedingly modern foundry which was completed several months ago. So complete was the new plant in all its appointments that it was possible to shift the work from the old foundry to the new without interfering with the regular operation of the plant.

As shown in Fig. 1 the main building is a large single story structure of saw-tooth construction, approximately 100 x 250 feet adjoining the 3-story brick and concrete pattern storage. This building, shown in the foreground in Fig. 1, is designed to carry two additional stories which will be added when more space is required. As indicated in Fig. 2, the saw-tooth type of roof construction affords ample natural light for the molding floor, while the unusually large proportion of the walls, devoted to pivoted sash, provides a means of natural ventilation. Artificial lighting is provided

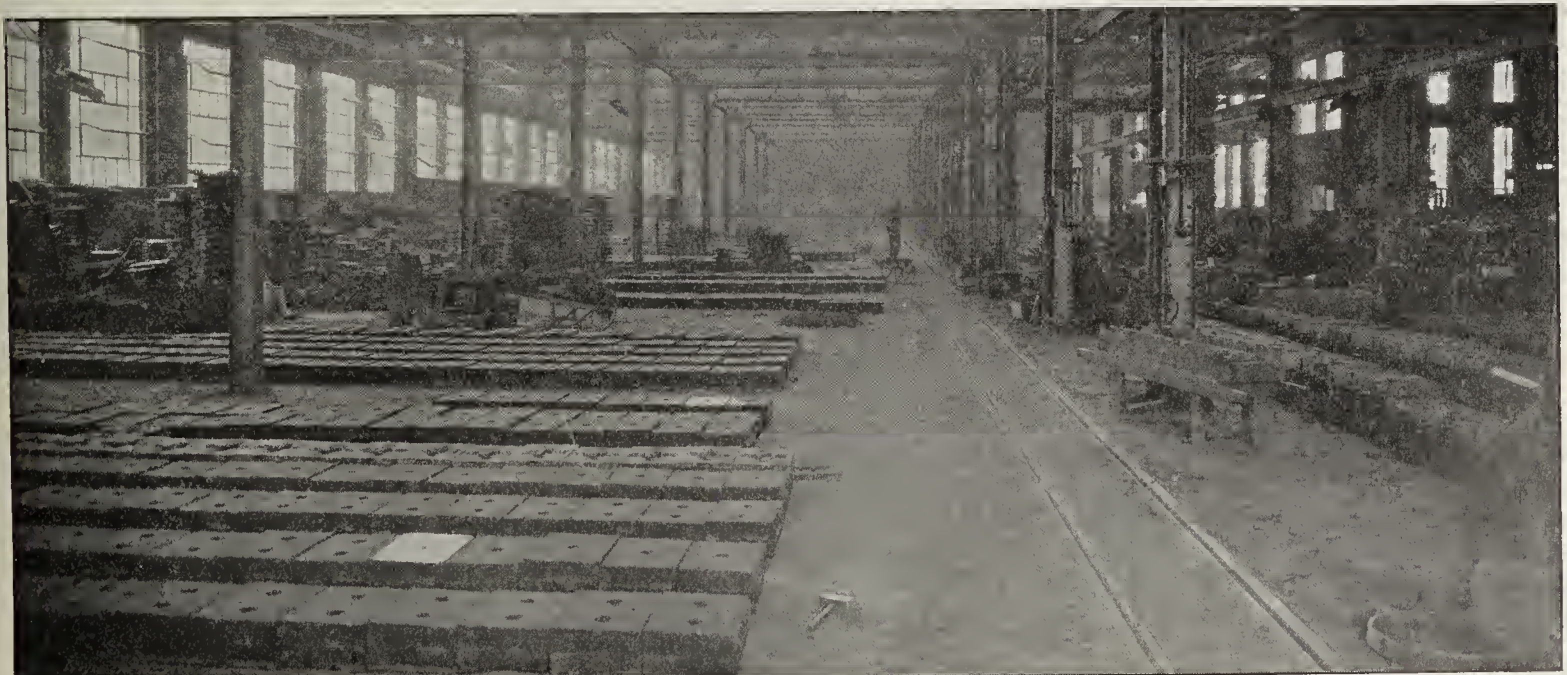


FIG. 2—VIEW OF MOLDING FLOOR SHOWING INDUSTRIAL TRACKS AND WOOD BLOCK FLOOR—THE CUPOLAS ARE SHOWN AT THE RIGHT

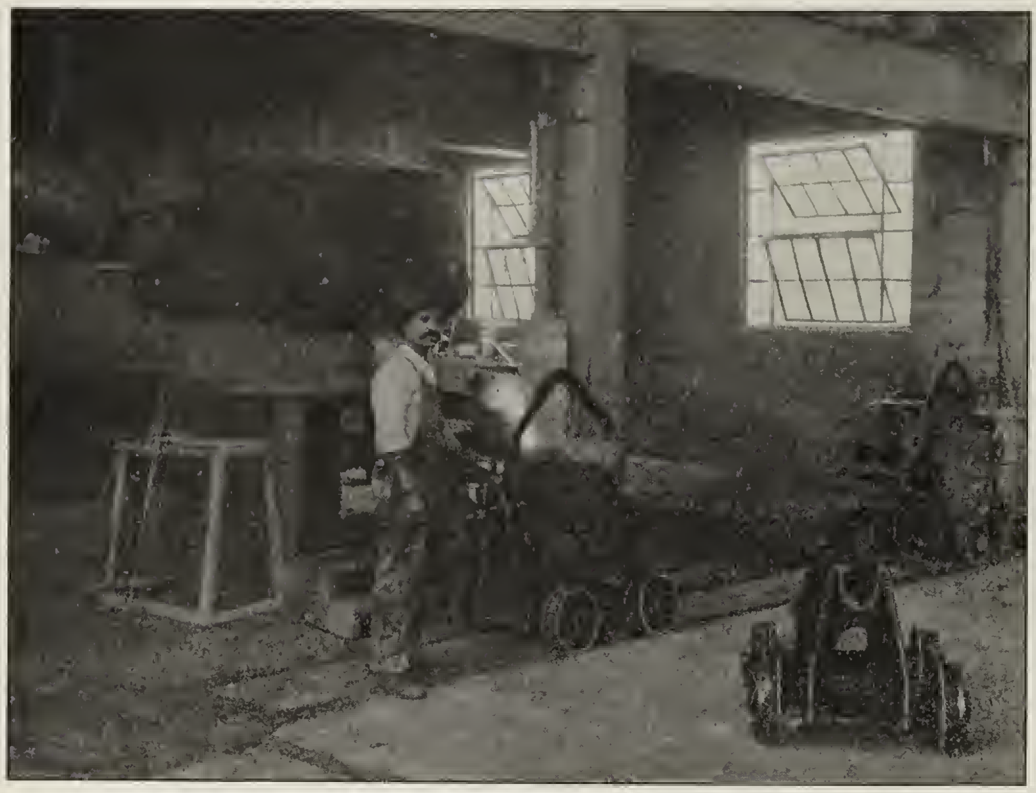


FIG. 3—TAPPING A CUPOLA—SHOWING THE METHOD OF CARRYING MOLTEN IRON TO THE MOLDING FLOORS

by means of mercury vapor lamps manufactured by the Cooper-Hewitt Co., Hoboken, N. J.

The main foundry is divided into four bays which extend north and south. In addition to the crane equipment, which will be mentioned later, materials may be handled in the molding room by trucks operating over the industrial track shown in Fig. 2. It will also be noted in this illustration that the floor is wood block installed by the Jennison-Wright Co., Toledo, O. Materials are delivered to the foundry over a siding of the C., H. & D., the main line of which passes alongside the foundry property. A locomotive traveling crane is used to move cars of material and to handle sand, coal, etc. Sand is stored in concrete bins. Practically all of the storage yard is paved with wood blocks which facilitate trucking of materials to and from the foundry.

Melting Equipment

Metal for the standard gray iron mixture is melted in two Newten cupolas built by the Northern Engineering Works, Detroit. The metal is passed into mother ladles carried on 4-wheel trucks running on the industrial tracks which extend to all parts of the molding floor and to the cleaning room. The molten metal is poured from the large ladles into hand-distributing ladles at convenient points in the molding room. The molds for heavier castings are made in the first two bays nearest the cupolas, and in pouring metal into these molds, it is taken directly from the large ladles suspended from cranes which serve these two bays. The electric traveling cranes were built by the Toledo Crane & Bridge Co., and are operated from the molding floor by ropes connected to General Electric control equipment on the crane bridges. In addition to the electric traveling cranes there are a number of chain hoists.

Malleable iron and semisteel are made in small, horizontal, cylindrical furnaces which were developed and designed by the Lunkenheimer Co. These furnaces, five of which appear in Fig. 5, consist essentially of a cylindrical shell of boiler steel securely bolted to castings whose ends are machined to roll on bearings, supported in heavy castings bolted to the floor. As shown in Fig. 5, the fuel oil and blast enter each furnace through a pipe suspended from the ceiling which terminates in a mixing chamber at a point opposite the center of the cast iron ends. Oil is used in connection with air to provide fuel for these furnaces. Two circular holes cut in the boiler plate shell of each furnace provide means for charging the material and for handling the molten metal. Each furnace is approximately 4 feet long and about 3 feet in diameter. When lined with fire brick and the necessary refractory materials, the capacity of each furnace is about 1200 pounds. A hand wheel in mesh with a

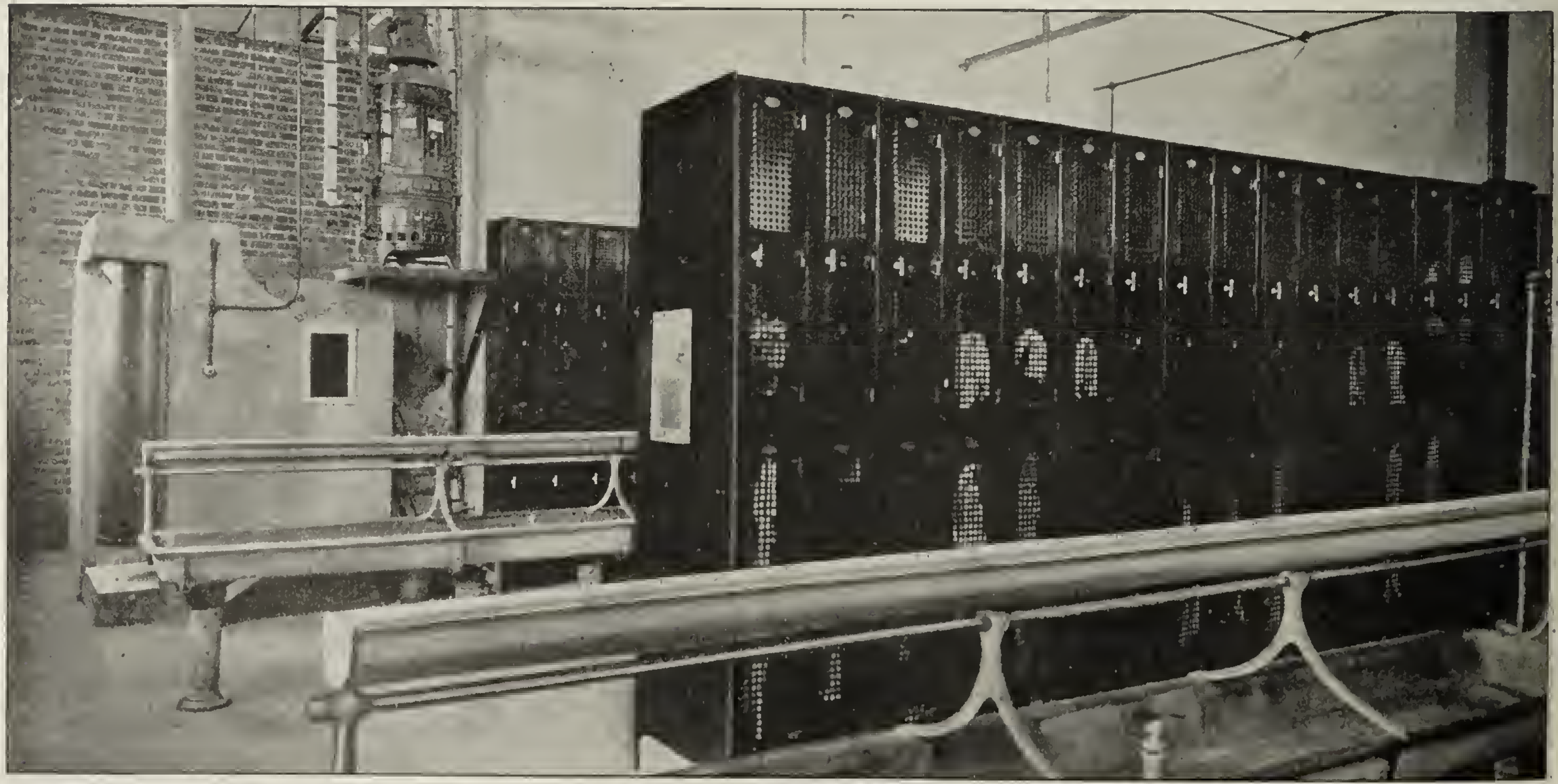


FIG. 4—A CLEAN AND WELL-LIGHTED WASH AND LOCKER ROOM IS APPRECIATED BY THE WORKMEN

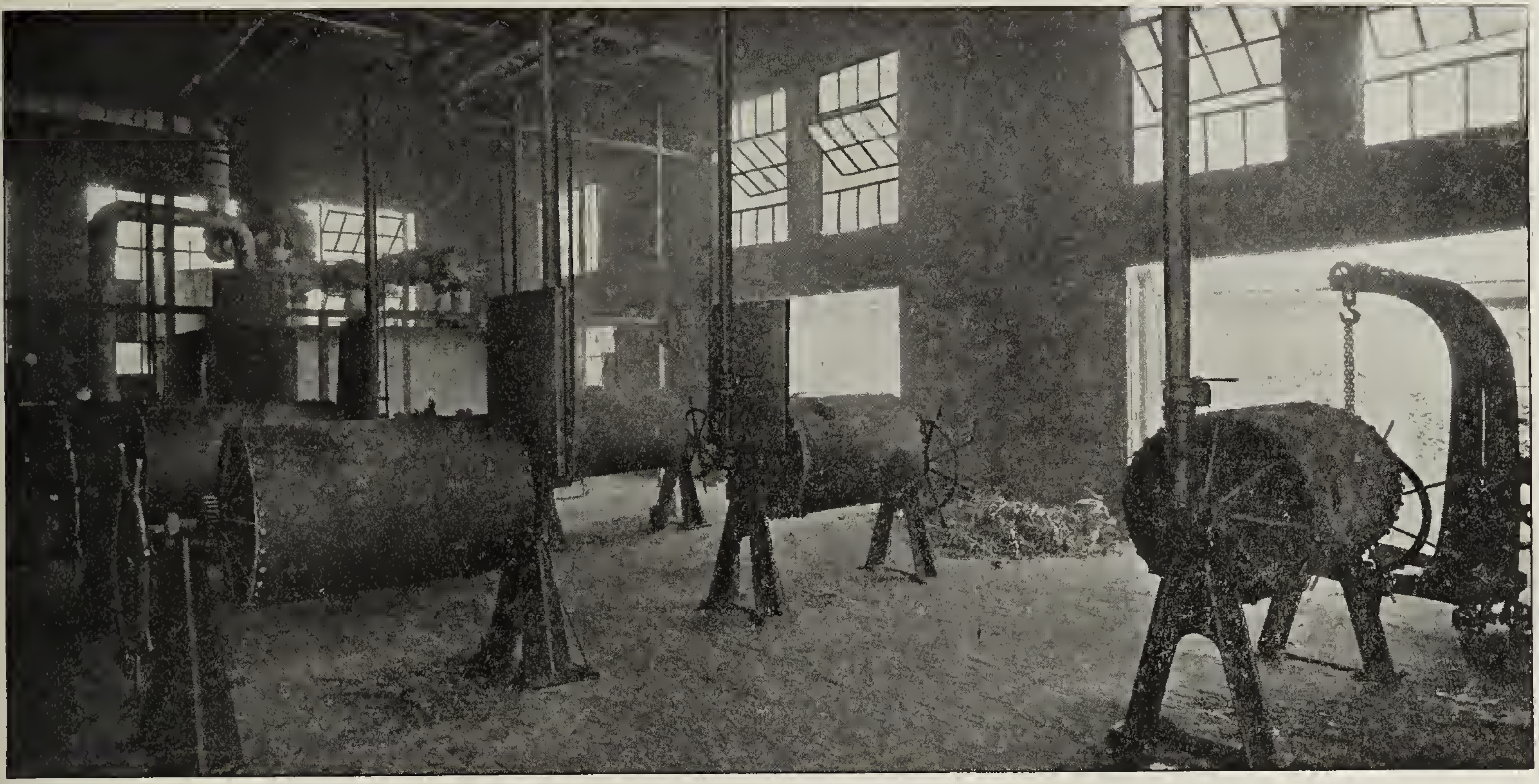


FIG. 5—SPECIAL GRADES OF SEMI-STEEL AND MALLEABLE IRON ARE MADE IN THESE SPECIALLY DESIGNED FURNACES

large gear wheel on the left hand side of each furnace permits the operator to tilt the furnace from one side to the other, thereby tumbling the mixture. The furnace shells are designed so that they are interchangeable, making it possible to remove one shell from its supports and to substitute another in a short time.

On account of the small capacity of these furnaces and the facility for thoroughly mixing the metal, it is possible to make a wide range of mixtures. One of the most successful metals produced in these furnaces has been what is called puddled semisteel. This is made by charging the proper materials in the furnace, then puddling the metal in the usual manner and rocking the furnace by the hand wheel. It is claimed that whereas the ordinary mixtures of iron used by the Lunkenheimer company show a tensile strength of from 22,000 to 25,000 pounds per square inch, the puddled semisteel acquires a tensile strength of more than 35,000 pounds. By using the proper grade of malleable pig iron, it is possible to make small quantities of malleable iron in these specially designed furnaces. Castings made in this manner are annealed in a gas-fired annealing oven adjacent to the east wall of the foundry building.

A large proportion of the molds made in the Lunkenheimer Co. plant are made on molding machines. The machine equipment consists of power and hand squeezers, and power jar and hand squeezers made by the International Molding Machine Co., Chicago; Adams Co., Dubuque, Ia.; Tabor Mfg. Co., Philadelphia; Mumford Molding Machine Co., Chicago; Wm. H. Nicholls Co., Inc., Brooklyn, N. Y., and the E. H. Mumford Co., Lebanon, N. J. Sand is prepared by mixers made by Wm. Sellers & Co., Inc., Philadelphia; Blystone Mfg. Co., Cambridge Springs, Pa., and the Sand Mixing Machine Co., New York. Riddles made by the Champion Foundry Machinery Co., Chicago, are used.

Core Room

The core room is situated at the north end of the molding room building. Cores are stored on home-made racks on a small balcony. These racks are shown in Fig. 8. The racks consist of a 2½-inch extra heavy pipe to which steel castings supporting common wooden shelves are bolted. This type of shelving can be made at a minimum cost and provides an unusually large amount of storage space for a given floor area. The core ovens, which also are at the north end of the molding room building, are gas-fired. The ovens are of the drawer type, being equipped with 16 swing drawers on one side and a number of larger compartments on the other.

One of the most interesting features of the Lunkenheimer plant is the pattern storage building which adjoins the north end of the foundry. It is a 3-

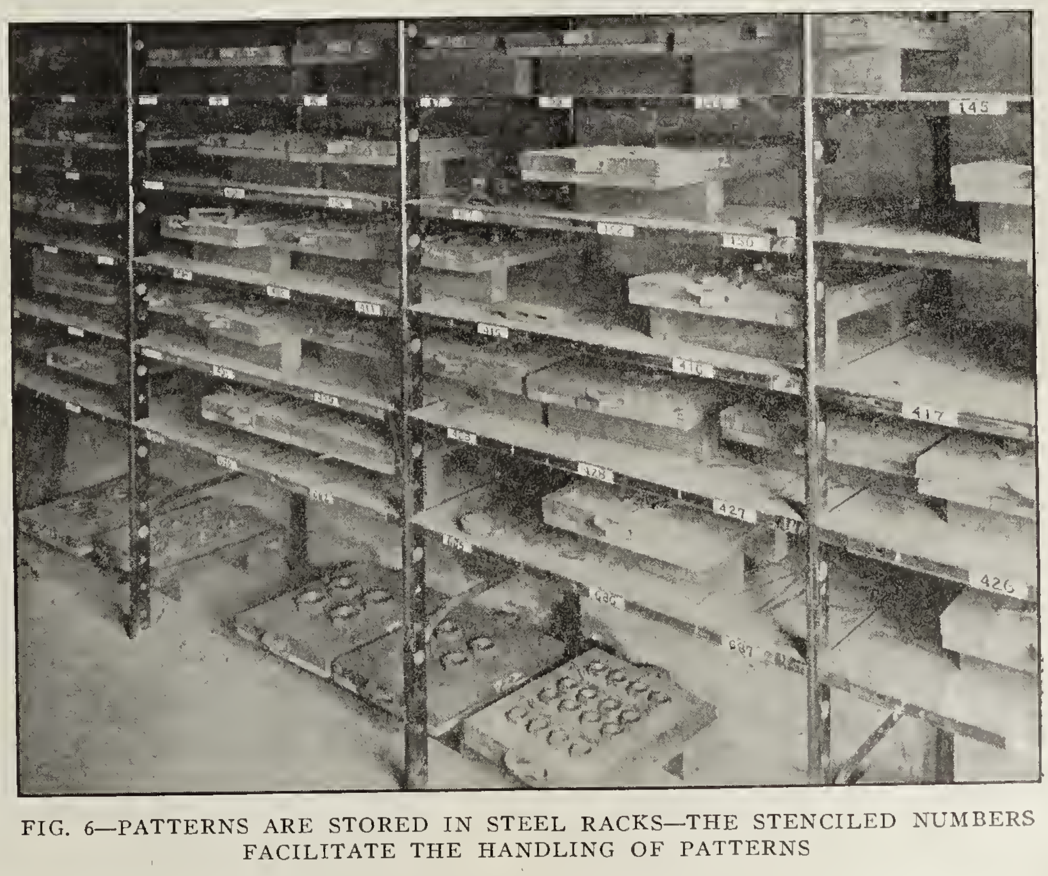


FIG. 6—PATTERNS ARE STORED IN STEEL RACKS—THE STENCILED NUMBERS FACILITATE THE HANDLING OF PATTERNS

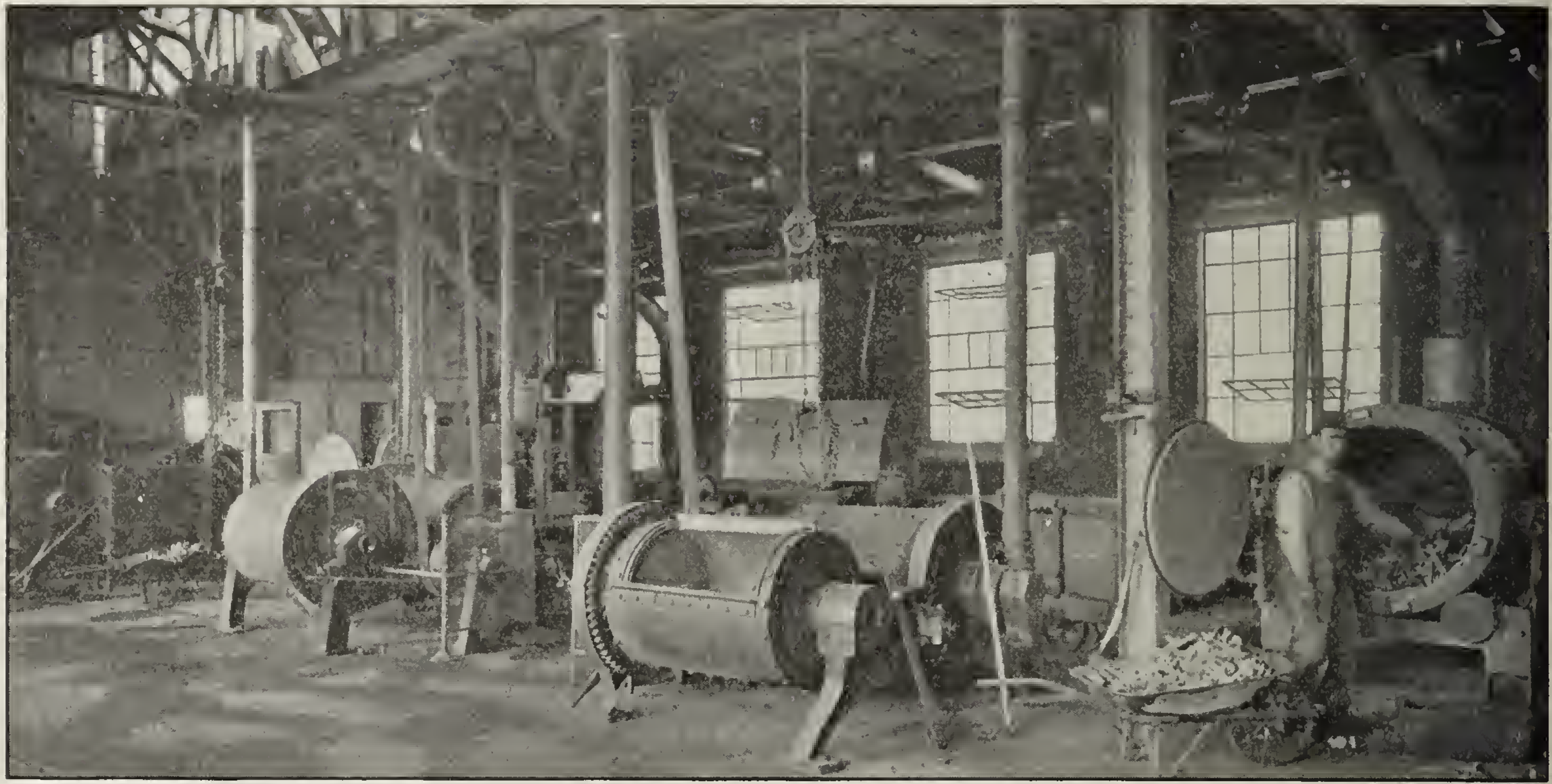


FIG. 7—A VIEW IN THE WELL-ARRANGED CLEANING ROOM—NOTE THAT THE SAND-BLAST MACHINES ARE AT THE ENDS OF THE ROOM, WHILE THE TUMBLING BARRELS ARE GROUPED BETWEEN THEM

story brick and concrete structure, protected by automatic fire extinguishers. Fig. 6, which shows a section of the shelving on which patterns are stored, conveys an idea of the neat appearance of every aisle in this building. As indicated in the illustrations, the steel shelving can be adjusted to accommodate any size of pattern, and the slides for pattern numbers facilitates the storage of patterns. It is interesting to note that in estimating the cost of steel and wood racks for pattern storage, it was discovered that the steel racks which were finally purchased, cost a few dollars less than wood racks strong enough to serve the same purpose. On account of the comparatively low ceiling of the floors in this building, the use of ladders is eliminated.

Cleaning Room

Fig. 7 shows a view of the cleaning room. The tumbling barrels are arranged in the center of the room, while the sand-blast machines are installed on either side. Chain hoists are provided to handle the doors of the tumbling barrels. The sand-blast machines were furnished by the New Haven Sand Blast Co., New Haven, Conn., and the tumbling barrels, by the W. W. Sly Mfg. Co., Cleveland, and the Whiting Foundry Equipment Co., Harvey, Ill. The grinding equipment consists of four double stand grinders made by the Norton Co., Worcester, Mass. Castings in the cleaning room are handled on industrial trucks made by the John C. Towsley Mfg. Co., Cincinnati.

In planning the new foundry, it was realized that well-ventilated and lighted working quarters are an inducement for employes to be more contented with their work. In line with this thought, the company has provided what is undoubtedly one of the best wash and locker rooms in any industrial plant in the country. Fig. 4 shows an interior view of the locker room which contains more than 150 steel lockers made by the Hart-Hutchinson Co., New Britain, Conn. A number of shower baths have been installed at either end of the room and hot water is provided for baths and wash basins by means of a Rudd heater shown in Fig. 4.

The new foundry was designed by Bert Baldwin & Co., engineers, and was built by Ross Bros., Cincinnati, contractors. The heating equipment consists of down-draft boilers and a radiator system installed and manufactured by the American Radiator Co., Chicago.

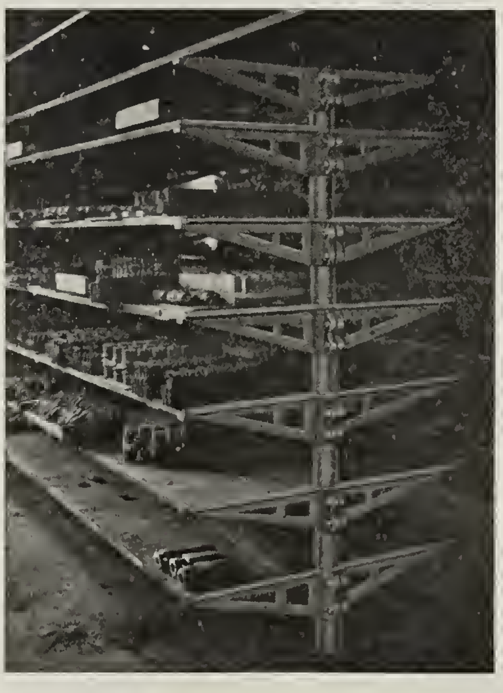


FIG. 8—HOME-MADE CORE RACKS OF COMMON PIPE, CAST BRACKETS AND WOODEN SHELVES

Melting Cast Iron in Crucibles

In a paper read at the annual conference of the Society of Chemical Industry, Birmingham, Eng., G. M. Walter stated that artificial gas is being largely used in metallurgical operations in the British Isles. The utilization of this fuel for metal melting has been greatly increased during the past 12 months and many thousands of pounds of brass, gun metal and aluminum are being melted daily with gas.

For the production and melting of aluminum alloys gas-heated furnaces are being employed that hold crucibles of 600 pounds capacity when melting copper and approximately 200 pounds capacity for aluminum. One of the more recent applications of artificial gas is in the melting of iron. In many instances cast iron is being melted in crucibles of 60 to 120 pounds capacity for the production of high-grade castings, and although the fuel costs are considerably higher than when using coke, the superior quality of the castings obtained more than justifies the extra fuel cost. In melting iron, about 700 cubic feet of artificial gas of a calorific value of 600 B.t.u.'s were required for each hundredweight of metal melted. The English hundredweight of 112 pounds is here indicated. From each crucible from seven to nine heats of iron were obtained.

Recently Developed Uses of Aluminum in Industry

The Ability to Weld and Roll Aluminum Has Been Responsible for Greatly Extending Its Application in Many Lines of Manufacture

By F G Shull

In preparing a paper on this subject I have chosen to refer to the following materials, practically all of which have reached stages of commercial importance during quite recent years:

Aluminum foil.
Aluminum bottle caps and jar closures.
Manufactures, involving autogeneous welding.
Die and pressed castings.
Tubing for store service.
Rolled rod for machining purposes.
Aluminum conductors, steel reinforced.

The aluminum foil industry has grown from practically nothing to a volume of business involving many tons of aluminum annually. At the start, the product consisted principally of plain foil, not appreciably unlike plain tin foil in appearance, which was used for wrapping candies, chewing gum, teas and the like. Later on the development of the process for embossing and printing aluminum foil opened up a large field among manufacturers of chocolate bars, cheese, toilet soaps, etc., so that today a very considerable tonnage of this foil is being used in the embossed and printed form.

Plain foil is being used to some extent in electrical condensers. A most recent use for plain foil, which has, as yet, just barely started, is for the lining of pulp board cartons for the packaging of coffee. This combination package possesses moisture resisting, and oil retaining characteristics not inferior to the tin can, as a coffee container.

Aluminum bottle caps and jar closures, like foil, have advanced from a meager beginning to a business of substantial proportions during a very few years. They are being used on practically all food products put up in glass. While this seal possesses the nonrefillable feature and requires no opener to remove, it owes its success, in a great degree, to the fact that it is aluminum, which is known to be nonrusting and strictly hygienic.

The development of a process of welding aluminum by means of the oxy-hydrogen and oxy-acetylene flame has opened an almost limitless field for the outlet of aluminum. Sheet aluminum of all gages heavier than 1/32 inch can be readily welded and the seam dressed off so that it is difficult to locate the joint. Consequently, it is possible to build-up an aluminum tank or container of almost any size and shape which when welded together, is practically a one-piece job. This class of material finds a place in breweries, ginger-ale plants, milk depots, chemical plants, and, in fact, wherever seamless metallic nonrusting containers are used. The one-piece feature is of marked advantage over the riveted tank which is always liable to spring a leak.

For a long time it has been considered a difficult proposition to die-cast aluminum. At the present time, however, this problem seems to have been solved, as there are several companies that claim to be successfully die-casting this metal.

High Pressure Aluminum Castings

Another quite recent development is the subjecting of sand castings to very high pressures in order to render the metal more dense and to increase the strength. Such castings have found application in making parts for the timing devices of shrapnel, it being found that these castings not only possess extra high strength, but that they also machine exceptionally well.

Aluminum tubing for pneumatic store service is not a new field for aluminum, strictly speaking, since it has been gradually coming into use for the past several years. It is a fact, however, that the last few years have seen the volume of aluminum consumed for this purpose reach a stage where the tonnage involved is of great importance. The natural characteristics of the metal itself principally recommend it for this use.

One of the most interesting developments in the aluminum industry of recent years is the rolling of high alloy rods in practically all commercial sizes. In the past, commercial aluminum rod has been largely a drawn product. This method of manufacture prevented the use of aluminum alloyed with any appreciable percentage of other metal, for the reason that in the drawing operation the surface, principally, of the rod is worked. The result is that the surface becomes hard while the body of the rod is left comparatively soft. Therefore, only the smaller sizes of drawn rod are suitable for machining.

By the rolled method of manufacture not only is it possible to use highly alloyed metal, but also the process tends to work the entire mass of the rod so that the finished product is a good, uniform, homogeneous material which machines well throughout its entire substance. This process, therefore, makes available a good machining aluminum rod in all commercial sizes for automatic machine and turret lathe products.

One of the first uses for which this rolled rod was tried was for the machining of the fuse-timing parts for shrapnel. While it worked perfectly for this purpose, it so happened that the principal timing parts were of such a shape that in making them from rod it was necessary to cut away a great deal of the metal, resulting in high scrap loss. It was found that sand castings of the general shape of the parts to be made could be subjected to a comparison process and rendered highly satisfactory for this purpose, with a minimum of scrap loss. Consequently, as a commercial proposition, the rolled rod could not compete with the compressed castings for this particular article. It will without doubt, however, fine wide usage for automatic machine products.

Aluminum cable, steel reinforced, is not a very recent aluminum product, it having been in commercial use on an extensive scale for the past few years. It is, however, sufficiently little understood to seem to warrant reference being made to it under the title of this paper.

The excuse for the existence of such a product as steel reinforced aluminum cable lies in certain inherent characteristics of aluminum which needed improving in order to recommend its use for long span, high voltage work. The particular characteristic to which I refer is the coefficient of expansion of aluminum, which is approximately one-third greater than that of copper. Due to this greater expansion, the aluminum line lengthens a little more with temperature rise, and shortens a little more with temperature fall, than copper. The result is that it is necessary to string

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Presented at the Boston meeting of the American Institute of Metals.

aluminum wire with greater sags than copper wire in order that its strength may not be overtaxed at low temperature. By allowing this greater sag at ordinary temperatures, combined with the higher coefficient of expansion of the aluminum referred to, one is apt to get excessive sags at extremely high temperatures in summer.

This was a condition of comparatively little importance in the early days of low voltages and short spans, but with the advent of higher voltage and long span steel tower construction, the characteristics of aluminum cable, as referred to, became a serious menace to its commercial existence.

What aluminum cable lacked was high tensile strength and low coefficient of expansion. In order to impart these characteristics it was proposed to make the center strand of a seven-strand cable, of steel, and the six outer strands, of aluminum, the steel to furnish the strength, and the aluminum the electrical conductivity. A very high grade plow steel wire was selected, which was triple galvanized to prevent corrosion, and the practical tests which followed proved that the theory was correct; that the composite cable took on characteristics different from either of the component metals, and was highly satisfactory for long span work.

It is found feasible to construct these cables with any standard number of strands, varying the proportion of steel and aluminum to meet the particular strength and sag conditions required.

Aluminum cable, steel reinforced, began to grow in favor from the start, so that today many of the most modern transmission lines on the American continent are built with this cable.

This, in a general way, will give a hint as to some of the more recent uses of aluminum. The automobile industry is, of course, the big factor in the aluminum business today, but the relative importance of some of the other fields for this metal seem to be in much greater demand than at any time heretofore.

Inspection of Brass and Bronze

By Alfred D Flinn and Ernest Jonson

IN 1913, extensive failures of wrought 60-40 brasses, or bronzes, so-called, began to be observed on a number of engineering projects in which these alloys of copper had been used in large quantities, as bolts, rods and plates. These failures have continued to come to the knowledge of the authors to the present time. Recently, the failures have not been so numerous, due in large part to the fact that at least in the project where the use had been greatest, the brass had been almost completely removed and steel substituted.

A number of failures of castings, due primarily to improper foundry methods, have occurred, and the form of failure was found to be cracks closely resembling season cracking of wrought brass. These were found to be due in all cases to repairs made by "burning-in" or welding and were proven to be of the same nature as season cracking. A few small castings of a broad U-shape failed by cracking apparently resulting from stresses set up by failure to afford opportunity for contraction during cooling. In the experience of the authors, correctly made bronze castings have been found highly satisfactory, and even some of the most imperfect ones have stood extreme abuse by hydrostatic and other tests without failure other than opening the incipient cracks so as to allow leakage.

Brass and bronze castings are expensive to make and, therefore, it is undesirable to reject such castings on account of defects which can be remedied. Minor leaks in hydraulic castings may be stopped by peening, but the fact that the casting leaks at a certain point generally indicates that the metal was defective at this point. If water comes through the walls of a casting, even in very minute quantities, under pressures which do not exceed 1000 pounds, this is an indication that the metal is not clean, or that the casting is porous from some other accidental condition. Peening, therefore, is a questionable method of treating defective spots in brass or bronze castings. If the defect is small and other circumstances permit, a hole may be drilled and a plug of the same metal as the casting may be screwed in. If plugging is not practical or permissible, defective spots should be cut out by chipping or drilling so that all the defective metal is removed. The cavity may then be filled by pouring metal into it from a crucible. In either case this must be done in such a way that the entire surface of the cavity is melted and thus consolidated with the added metal. If a gas flame is used, there is some danger of the filling not being solid, but if it is poured from a crucible with reasonable care, there can be no doubt about the soundness of the metal in the weld.

Cooling Stresses

Brass and bronze when stressed above the initial yield point for a considerable length of time, will fail by cracking, when oxidation takes place on the surface, which will happen sooner or later. When a defective spot in a casting is welded, the cooling of the metal in the weld will be accompanied by contraction which will put a tensile stress in the metal of the weld as well as in the old metal which surrounds it. If the metal of the weld is the same as that of the casting, its elastic limit may be appreciably higher than that of the rest of the casting, because the metal in the weld solidifies much more rapidly than the rest of the casting did originally. The permanent deformation resulting from the shrinkage of the weld therefore, will take place in the surrounding metal, and this metal will remain in a state of tension greater than its initial yield point and after a time cracks will appear. The magnitude of the stresses thus caused may be estimated from the fact that the shrinkage of brass from the freezing point down to ordinary temperature is about 3/16 inch per foot or about 1.5 per cent. If the elastic limit were high enough, this shrinkage would produce a stress of not less than $14{,}000{,}000 \times 0.015 = 210{,}000$ pounds per square inch. In other words, the metal surrounding the "burn" will be stressed beyond the yield point. The "burn" itself, while stressed as high as the surrounding metal, may not be stressed to the yield point because, being chilled from pouring into the cold casting, it gets a higher yield point than the same metal cast in sand.

If the casting is of small lateral dimension, and the ends are not constrained, and the break extends all the way across it, the stress set up in the old metal by the shrinkage of the weld is compressive, and, therefore, there is no danger of cracking. In other cases shrinkage stress must be prevented by keeping the casting heated to a very high temperature while the weld is being made and until it has solidified. The yield point of the surrounding metal thus will be temporarily lowered and the flow will take place under a stress much lower than the yield point of the cold metal, so that there will be no danger of cracking after the metal has cooled. Another way to prevent cracking is to anneal the casting immediately after the

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From a paper presented at the annual meeting of the American Society for Testing Materials, held at Atlantic City, June 26 to 29.

weld has been made. There is no reason to believe that the metal surrounding the weld is injured by the shrinkage stress until corrosion occurs on its surface. Therefore, if the yield point of the metal surrounding the weld is lowered by heating the entire casting to a sufficiently high temperature, additional flow will occur, and the cooling stress thus will be gradually reduced to a very small minimum, according to the length of time the annealing is continued. The annealing temperature should be maintained for several hours so as to give the metal time to flow.

There should be definite specification requirements to control the "burning-in" process. The specifications for manganese bronze castings should cover this point in such a way that absolutely safe castings will result, even when defective places have been "burned-in," merely by putting the specifications into the hands of a careful and experienced metal inspector who has no special familiarity with brass.

It now appears that the only way to insure safety in brass (bronze) castings is to specify annealing at a certain temperature for a certain length of time whenever "burning-in" has been done.

Brass and bronze castings are subject to various defects which are difficult to discover by surface inspection, or even by hydrostatic testing. The defect which most commonly occurs results from the inclusion of oxide in the metal of the casting. This occurs in two ways, either the molten metal contains an admixture of oxides, owing to insufficient protection of the molten metal from the air, or the dross from the surface of the crucible or furnace charge gets into the mold and is caught at some point where the flow is slight, and is thus prevented from coming to the surface in the risers. In the former case the entire casting is bad, and the best way to discover this defect is to make tensile tests on specimens cut from a coupon cast from the same melt. The admixture of oxide is indicated most distinctly by the greatly reduced elongation, but also by low ultimate strength. The tensile test therefore, should be specified for all important brass and bronze castings, no matter whether a certain strength and elongation are of mechanical value or not. The metal in every important brass or bronze casting should have the strength and elongation typical of the mixture of which it is made as an evidence that the metal in the casting is clean. If a tensile test is impracticable, oxidation in the metal may be discovered by making a bending test on a machined specimen. The presence of oxide then will be indicated by a number of small cracks which open on the outside of the bend, and if the oxidation is extreme, also by the abnormal color of the surface of the fractured specimen. Experience of the authors indicates that oxidation of metal in the crucible is a very common defect, especially of the mixtures containing high percentages of copper, that is, of the bronzes. It is the belief of the authors that in foundries where tensile or hydrostatic tests are not made, the metal is generally allowed to become considerably, and in many cases seriously, oxidized in the crucible, because this defect in the metal does not show on the surface of the casting. To specify bronze castings merely by the mixture therefore is useless. Unless the metal is tested after it has been poured, one is not justified in assuming that it consists of a clean, uniform mixture of the ingredients put into the crucible. A bronze casting may be made of the correct mixture and may show no surface indications of defects, and still it may be nothing but a honeycomb of metal, filled with oxide.

The presence of included dross is more difficult to discover. If a hydrostatic test cannot be made, it is practically impossible to find such defects unless they happen to come to the surface of the casting, and even a hydrostatic test does not always discover such defects, because there may be a considerable thickness of good metal along one or both of the surfaces of the casting. The best insurance against this kind of defect is correct molding, a thing which, strange to say, is unusual.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Shrinkage of Aluminum Match Plates

Using No. 12 ingot aluminum for making match-plates, we find that the shrinkage is excessive. We recently made a plate, 11 x 18 inches, which was flat on the cope side and which was fed by four risers, ⅝ inch in diameter. This plate developed excessive shrinkage, notwithstanding the precautions taken.

Your trouble is due to insufficient feeding. A riser, ⅝ inch in diameter, is too small for this purpose. Furthermore, the head of metal thus obtained is too low to secure the requisite pressure since aluminum is approximately one-third as light as copper. A much higher head is required to get the same pressure in the mold. Therefore, it would be advisable to double the length of the sprues and risers and to increase the diameter of the latter to two inches. In some cases where the section of the metal on the plate is extra thick, it may be necessary to use risers three inches and more in diameter and to build them up several inches higher than the sprues. When the plate has been poured, the tops of the sprues are covered with sand and are weighted down and the risers are filled with molten metal to increase the pressure over the surface of the plate.

Bronze Substitute for Malleable Iron

We would like a mixture for a brass, bronze or aluminum alloy that will serve a similar purpose as malleable iron. The alloy should be difficult to bend but easy to machine.

The following alloy will be found suitable for the purposes outlined: Copper, 88 per cent; tin, 10 per cent, and lead, 2 per cent. If a cheaper mixture is desired, the following can be used: Copper, 60 per cent; zinc, 38 per cent, and lead, 2 per cent.

Aluminum Solders and Flux

We would like the formula for making an aluminum solder and information on the most desirable fluxes.

A mixture extensively used for soldering aluminum follows: Aluminum, 2.5 per cent; phosphor tin, 2.5 per cent; zinc, 27 per cent, and tin, 68 per cent. Melt the zinc and add aluminum, tin and phosphor tin.

The following mixtures also are used:

Aluminum, 10 per cent; copper, 5 per cent; zinc, 50 per cent; tin, 32 per cent, and phosphor tin, 3 per cent.

Tin, 80 per cent; lead, 17 per cent, and aluminum, 3 per cent.

Tin, 80 per cent; aluminum, 17 per cent; magnesium, 2.5 per cent, and nickel, 0.5 per cent.

Tin, 50 per cent; lead, 26 per cent; zinc, 23 per cent, and copper, 1 per cent.

Various fluxes are recommended for aluminum solders, one inventor preferring stearic acid, another oelic acid, 90 per cent and ammonia 10 per cent, while practical men applying solder use sulphuric acid to remove the oxide from the surface of aluminum and follow with tallow. A dozen different methods of soldering aluminum are being practiced and some creditable work is being done. Considerable skill and expense are required to produce satisfactory work and with these essentials taken care of, it seems immaterial what kind of an alloy is employed for soldering.

Brazing Metal

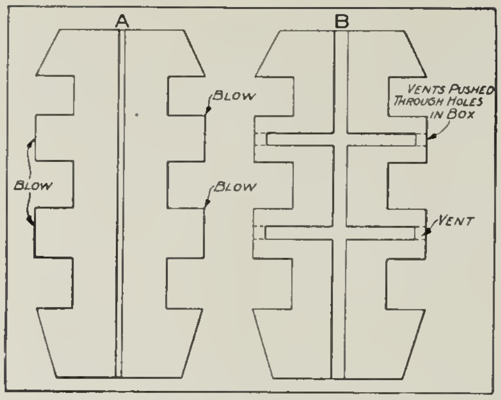
Kindly furnish us with a mixture for brazing metal. We are experiencing considerable difficulty in securing good castings made from the mixture we are using. While the castings appear to be sound, when machined, they are porous.

Since these castings melt easily while brazing it is evident that the mixture is at fault and that you are using a dip metal instead of a brazing alloy. The following mixture will withstand the brazing temperature without melting: Copper, 86 per cent; zinc, 12.5 per cent, and lead, 1.5 per cent. The lead is added to facilitate machining. Melt the copper quickly under charcoal, using a flux, such as bottle glass, to exclude the air and before the copper is melted add a small amount of salt. Deoxidize the metal with 0.25 per cent of 15 per cent phosphor-copper, stir thoroughly, add the zinc, which has been previously warmed, and follow with the lead. Use coarse sand for molding and coat the mold with plumbago. Provide heavy risers on all thick sections and if the castings have flanges, mold them with the face of the flange in the drag.

Venting Cores for Brass Work

We are experiencing difficulty with the cores shown in the accompanying illustration, since they blow at the points indicated. Our mixture consists of lake sand, 216 pounds; Albany said, 192 pounds; mill room sand, 216 pounds, and core oil and binding powder, 11 quarts. The cores must be made on end and, therefore, we must have a mixture that will prevent the sagging of the cores while baking.

Your difficulty is due to the insufficient venting of the core. If it could be made in halves, it could be more thoroughly vented, but since this is not possible, holes should be drilled in the core box at each of the extensions so that the cores may be vented horizontally to the center vent. The openings on the outside of the core should be filled after the core has been dried, to prevent the metal from entering these vents. However, before filling these openings, a vent wire should be passed through as a final precaution to ascertain whether or not the vents are closed and whether they are connected to the center vent. In the accompanying illustration, *B* is a sectional elevation of the core showing the proposed method of venting to avoid blowing, and *A* is a sectional elevation of the core showing the present method of venting.

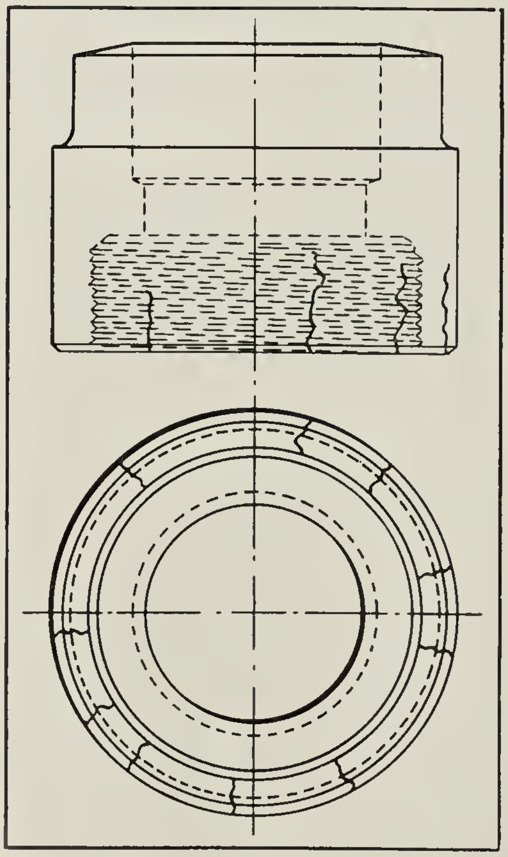


SECTIONAL ELEVATIONS OF A CORE SHOWING PRESENT AND RECOMMENDED METHODS OF VENTING

Brass Alloys for Piston Rings

We would like to obtain the formula of an alloy for a brass that is suitable for piston rings. These must pass over the end of the piston and spring to place in the groove.

There are two different types of alloys used for the purpose of making springs; one is a phosphor bronze, and the other is a yellow brass containing iron. As the latter metal is difficult to cast into bars, 3 inches in diameter, and to obtain clean castings, it will be necessary to use the following phosphor bronze alloy: Copper, 91.75 per cent; tin, 5 per cent; zinc, 2 per cent, and lead, 1 per cent. When the copper is molten, add 0.25 per cent of 15 per cent phosphor copper.



CRACKED CYLINDER CAP

Cylinder Caps Which Crack

We are experiencing considerable difficulty in casting the tubular well cylinder cap shown in the accompanying illustration. Cracks occur in the threaded ends. We use practically an all-scrap mixture which we do not ingot. Our mixture approximates copper, 65 per cent, and zinc, 35 per cent.

It is probable that by the use of chills the cracking of these castings might be obviated, since the chills would cause the thin section of metal to set rapidly. However, it might be advisable to make a softer core, particularly that section of it adjoining the section of the casting that cracks. If an oil sand mixture is being employed, change to a starch or rosin binder and even though this may slow up production the reduced casting losses will more than compensate for this increased cost. The chills will have to be applied externally in the form of a ring of brass or copper. Whether this is feasible, it is impossible to judge, since the casting may be molded in several ways. We are of the opinion that the use of chills will slow-up production so that even if the castings were more satisfactory, the gain would be very slight over the methods now in use with its attendant losses. Changing the cores to get them softer, either by burning them or by using a different binder, we believe is the more practical way of overcoming this trouble.

Aluminum for Cooking Utensils

We would like to know whether pure aluminum can be used advantageously for casting cooking utensils, or whether it can be used to better advantage when some other metal is mixed with it.

If it is your intention to produce cooking utensils regardless of cost, the purer the aluminum, the better. Tests have proven that no aluminum for this purpose should contain more than 2 per cent of impurities, but unless this metal is rolled into sheets and stamped to form, it will be too soft for the purpose mentioned. Cast aluminum utensils frequently contain a considerable percentage of zinc, as this cheapens the alloy. When the zinc content is high, however, the casting difficulties are increased. For the purpose mentioned, the following alloy has good casting properties: Aluminum, 82 per cent; zinc, 15 per cent and copper, 3 per cent.

Solving Foundry Transportation and Conveying Problems

Design and Application of Modern Labor-Saving Equipment for Foundries

By Robert E Newcomb

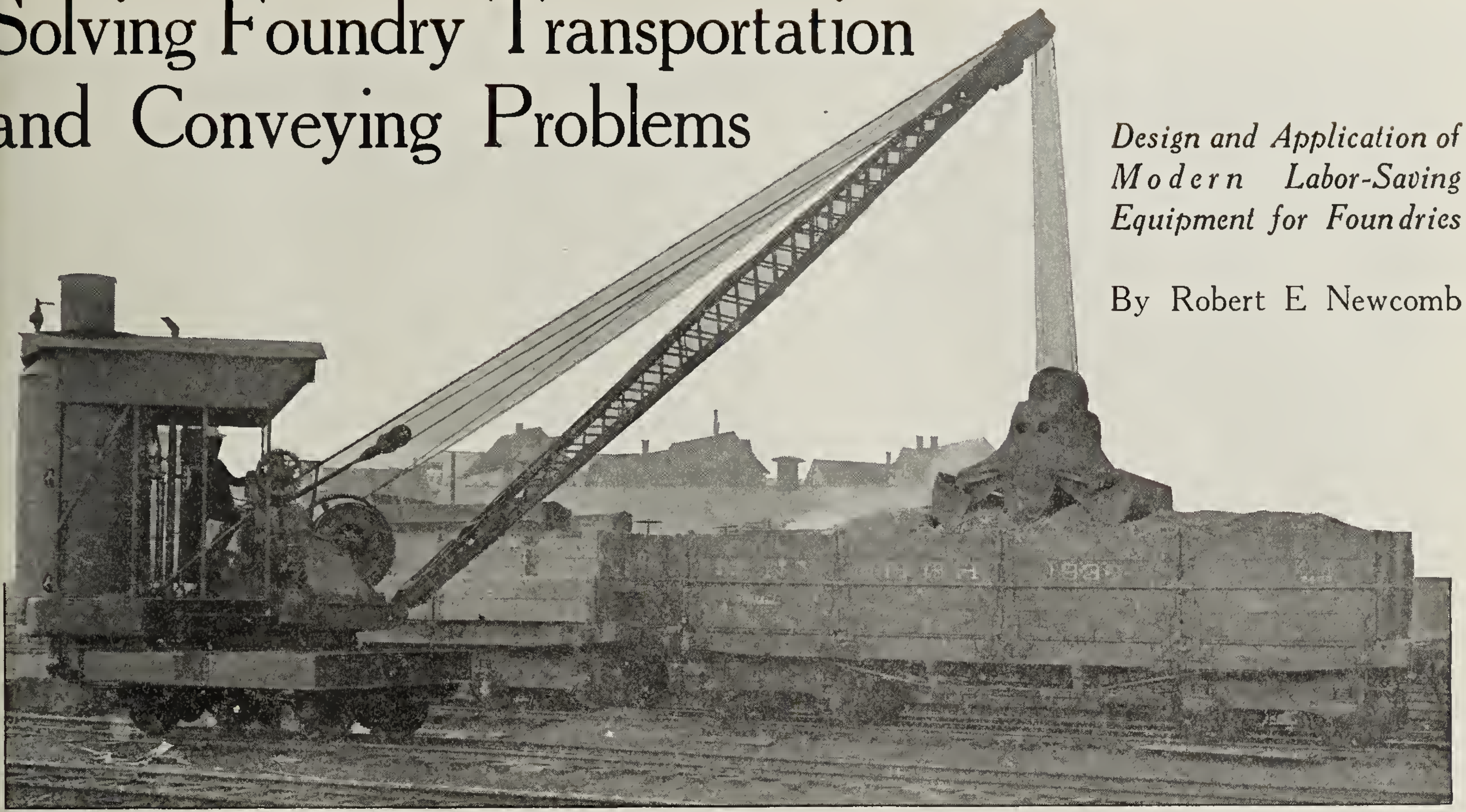


Fig. 1—Locomotive Crane and Bucket Unloading a Car

THE elimination of physical effort of the skilled mechanic or any other workman should increase his productivity. The introduction of the small molding machines of the squeezer type has generally been followed by the opposition of employes as the individual physical effort per hour is multiplied, though decreased, per mold.

The jar ram molding machine for the heavier side floor and crane floor work, has made a substantial reduction in the physical effort of the employe, while at the same time multiplying production.

The production of a molder or coremaker is in part limited by his physical capacity for work. It is further limited by the individual's adeptness and the patterns and core boxes supplied to him. Foundrymen are cognizant of this fact and some supply the best tools most conveniently accessible. Many foundry managers overlook the partial elimination of common labor. Notwithstanding the fact that the day laborer works for half the wages of a skilled mechanic, oftentimes his wages represent half the total labor cost of castings. This is especially true where skilled mechanics do laborers' work.

Methods of reducing labor effort through the elimination of ramming are important and have been described many times, hence this article is addressed to the foundryman wishing to reduce his common labor. In my experience, I have found that the foundry is one of the last places where the unskilled man wishes to be employed for the reason that the work is usually more laborious than many other employments, and further, due to organizations limiting the development of the laborer into a skilled mechanic.

Many foundry managers have been slow to apply mechanical equipment to reduce the cost of unskilled labor. Those who had the foresight to apply what other industries have used for some time have reaped a harvest. Foundrymen should be more familiar with the most common mechanical equipment, most important of which is the traveling crane.

Cranes and Their Application

A crane for the foundry should have smooth regular motion and for this reason the direct-current motor crane is preferable. More recently, the alternating-current motor crane has been applied to foundry service with satisfactory results, yet it does not give the same smooth action that is obtained from a direct-current motor crane. The alternating-current motor crane, however, has many advantages. The motor is of more simple construction and has no commutators and commutator brushes to wear and give trouble.

The motors of the direct-current motor crane should be thoroughly enclosed to protect them from the dust and dirt of the foundry. In fact, it is also well to specify enclosed alternating-current motors even though it increases the cost.

The controllers are the next most important part of the electrical equipment of the crane, hence the purchaser should consider them carefully, determine the number of points of control of the competitive cranes and the merits of the details of the design. Controllers should be of such size and shape and so located in the cage that they will not interfere with the operation or be an obstruction to the operator when handling loads almost beneath the cage.

The switch-board is of next importance, electrically, as on it is mounted main switches, fuses, circuit breakers, etc., by which current is properly distributed to the several motor circuits and automatically as well as manually disconnected.

Fig. 5 illustrates a three-motor crane cap made by the Pawling & Harnischfeger Co., Milwaukee, complete with switchboard controller and resistance. The roomy cage, orderly arrangement of controllers and location of resistance, is well illustrated.

A modern safety limit switch device is employed in the most modern cranes. A rising hook moves a switch lever to prevent overtravel of the hook and consequent damage. This is a most essential feature of a hoist and its reliability should be thoroughly investigated. If, through carelessness of the operator, the hook should be

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Abstract of a paper presented at the twenty-second annual meeting of the American Foundrymen's association held at Boston, Sept. 24-28. The author, Robert E. Newcomb, is associated with the Deane Works, Worthington Pump & Machinery Corp., Holyoke, Mass.

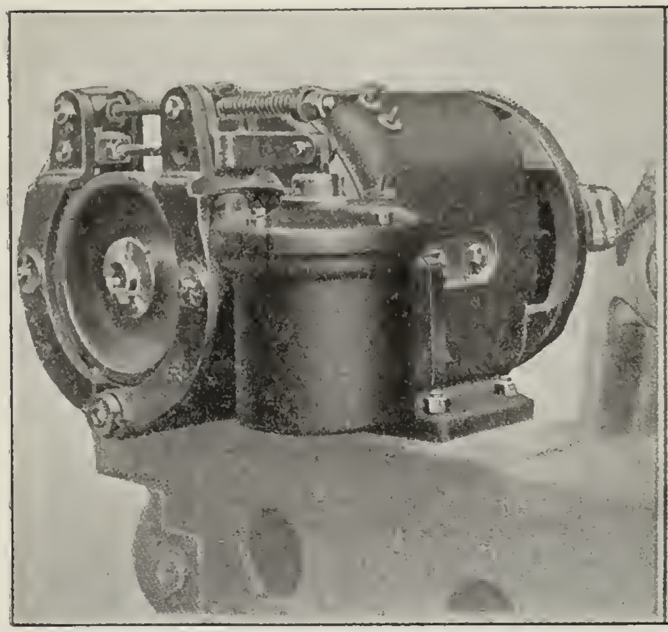


FIG. 2—DIRECT CURRENT MOTOR WITH CLAM SHELL BRAKE

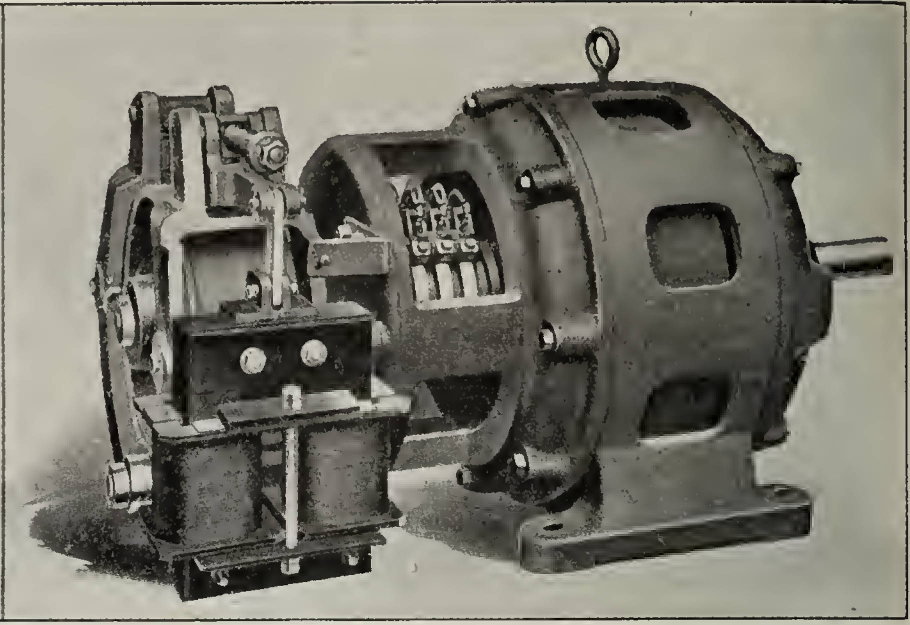


FIG. 3—ALTERNATING CURRENT MOTOR AND CLAM SHELL BRAKE

hoisted too high, an electric limit switch automatically interrupts the current and brings the motor to a quick stop. This switch, which is enclosed in a box and operated directly from the bottom block, carries only an auxiliary current which operates a magnetic switch, mounted on the switchboard. This magnetic switch, which carries the motor current, is provided with carbon arcing contacts and a powerful magnetic blow-out. After the limit switch has been opened by the hook, the load cannot be hoisted any further. However, it can be lowered in the usual manner, whereupon the limit switch will again close automatically. If for any reason the limit switch is not in operative condition, the magnetic switch will immediately open. This limit switch is called a closed-current type and is said to be absolutely dependable and foolproof.

Fig. 2 illustrates a common form of electric solenoid brake which automatically goes into service the moment the power is cut off from the circuit.

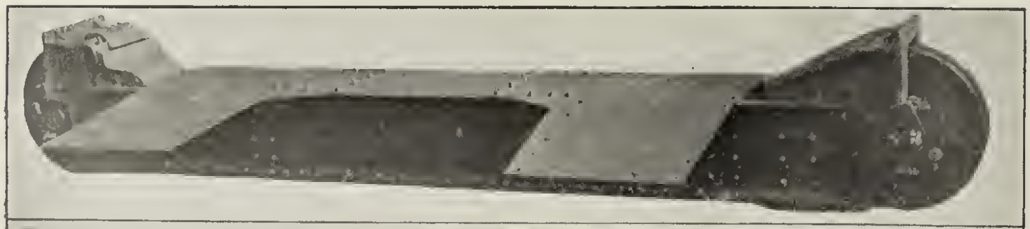
The bridge girders should be of ample stiffness and strength, well secured to the bridge end trucks by riveted gussets as shown in Fig. 4*a*, and which should be equipped with bearings of the Master Car Builders' type, similar to those shown in Fig. 4*a*, permitting easy removal and replacement of truck wheels and bearings. Fig. 4*b* illustrates the end truck construction employed by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., in which the truck framing surrounds the wheels fitted to axles keyed into the hub. This construction illustrates self-oiling, self-aligning bearings set into openings in the truck frame and easily removable. This shows how to thoroughly enclose and protect from dust all bearings and gears. Bridge trucks should also be equipped with suitable bumpers to prevent damage or injury when bumping the end of the runway or other cranes, unless the bridge and frame forms a protection, as shown in Fig. 4*b*. Truck wheels should be steel castings and double-flanged or cast iron with chilled treads.

The crane trolley should be of compact construction and designed to resist or compensate for tortional movement due to inequalities in the track or runway. The hoist gearing should consist of machine-cut steel gears thoroughly enclosed and well supported between bearings, preferably operating in a bath of oil.

It is suggested that purchase specifications for traveling cranes contain the following clauses:

All trolley gears to be of open-hearth steel castings or of better material, and all pinions of suitable forged steel. Gears to be fully enclosed. Said enclosures and crane in general to be so constructed as to meet the most exacting requirements of the state industrial accident board or government authorities having jurisdiction therein, and the American Society of Mechanical Engineers code of safety standards for cranes.

Lubrication must be adequate and lubricating reservoirs and oil holes to



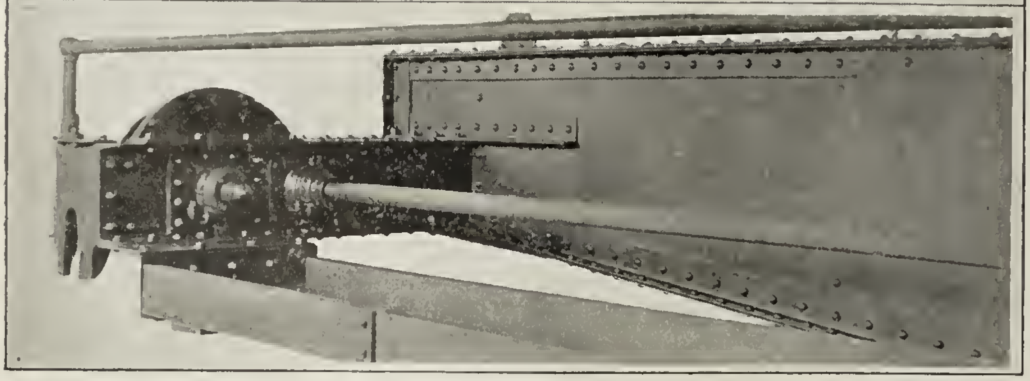


FIG. 4a—END TRUCK CONSTRUCTION FIG. 4b—END TRUCK CONSTRUCTION SHOWING DRIVE AND ENCLOSED BEARINGS

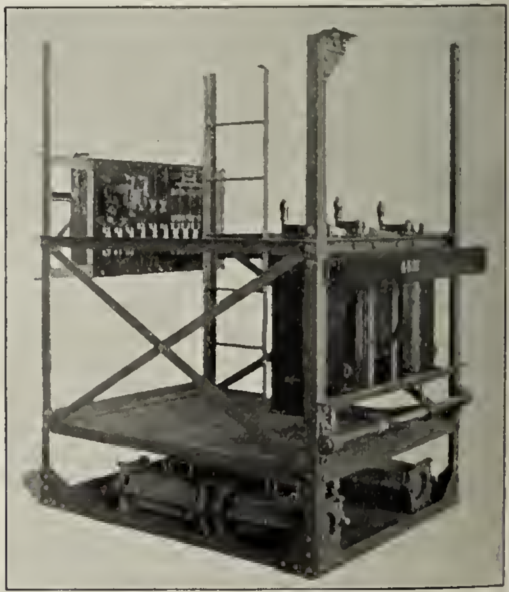


FIG. 5—CRANE CAB ILLUSTRATING ARRANGEMENT OF SWITCH-

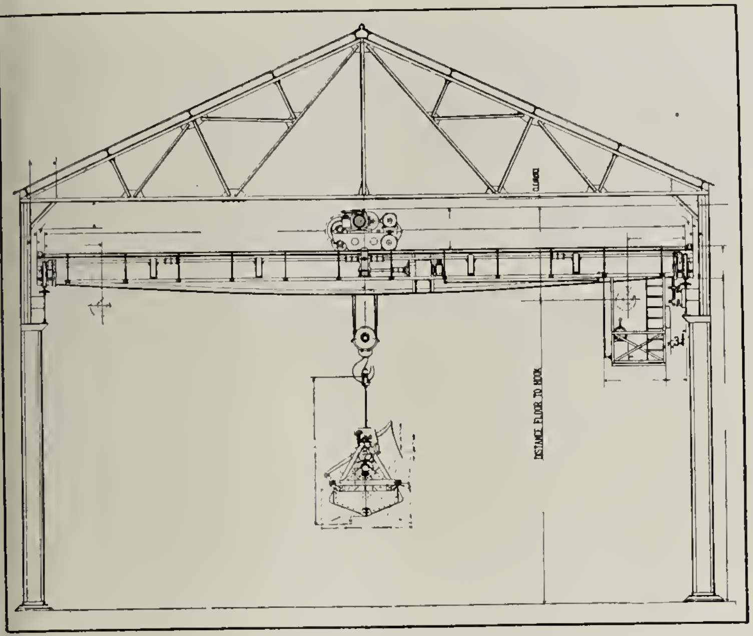


FIG. 6—PRACTICAL CLEARANCE DIMENSIONS OF BUCKET ON CRANE

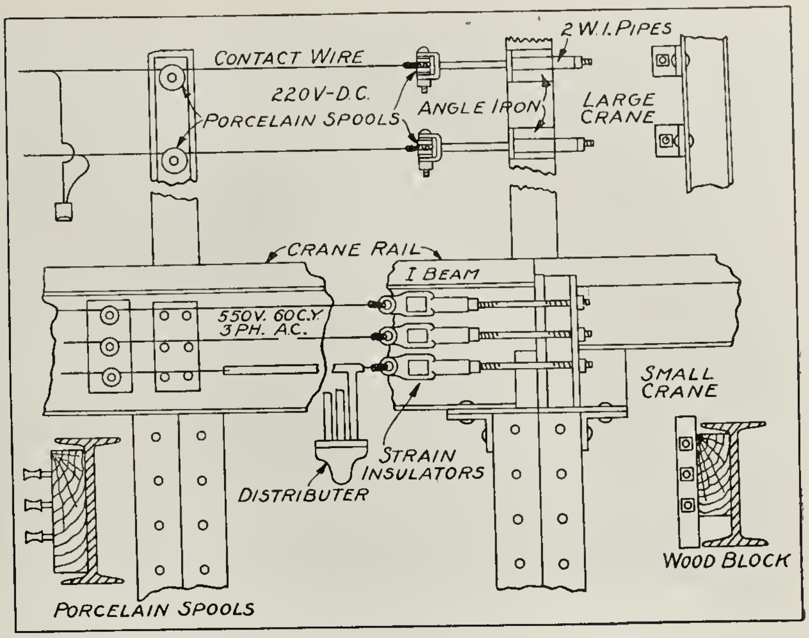


FIG. 7—METHOD OF SECURING AND SUPPORTING TROLLEY WIRES ON CRANE RUNWAY

be of such proportion as to insure a sufficient supply of lubricant reaching all parts to be lubricated. These parts should be so designed as to not require inspection or refilling more than once per day. All gears to operate in a bath of oil.

Wiring to comply with the rules and regulations of the National electric code of the National Board of Fire Underwriters and acceptable to the local electrical inspector having jurisdiction throughout the district where the crane is installed.

Crane to be guaranteed to the purchaser in design, workmanship and material. Guarantee to be good for one year from date of installation.

The foregoing clauses are somewhat rigid and some makers will not wish to comply with them. Nevertheless, they are desirable, as the manufacturers who object must acknowledge the inferiority of their equipment in these respects, hence, the selection may be made with a more complete knowledge of these essential characteristics of crane construction.

A Suggestion to Purchasers

It is suggested that purchasers determine by measurements, regardless of drawings, that they have ample runway clearance, as, frequently, building construction does not accurately conform to drawings. It is unsafe to purchase a crane having less than a 6-inch side and overhead clearance. See Fig. 6 for clearance dimensions required.

The crane runway wire should be of ample size for the addition of one or more cranes; it should be of hard drawn copper wire supported on insulators, as shown in Fig. 7.

The following illustrations show some of the more unusual applications of a traveling crane. Fig. 8 illustrates a single-line grab bucket, made by the Pawling & Harnischfeger Co., suspended from a crane hook. Fig. 9 illustrates the operation of a grab bucket in a foundry. These grab buckets are designed to hold from 1 to 1½ cubic yards and may be conveniently used for transferring such materials as molding sand in conjunction with sand-mixing machines.

A foundry melting 30 and 40 tons of iron per day has 75 to 100 tons of sand distributed upon the molding floors. It is customary for the molder to cut and temper this sand. The manual cutting and tempering of sands is a prolific cause of bad castings not easily controlled. The introduction of motor-driven portable sand-mixing machines, as shown in Fig. 12, may be operated and conducted by a specially trained operating crew with improved results. The machine illustrated was made by the Sand Mixing Machine Co., New York.

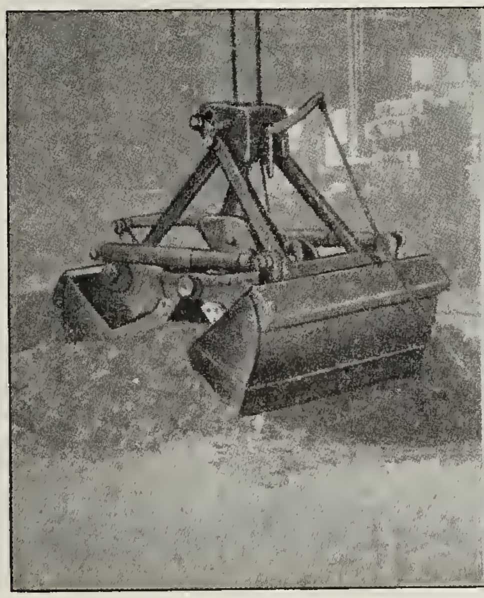
In other foundries, belt and bucket conveyors are used to return the sand to a central sand mixing and tempering plant, which is, of course, first rate practice as this quantity of sand may easily be handled to and from the molding floors at a cost not to exceed $0.01 to $0.02 per ton and within one hour's time. Such an equipment may cost from $20,000 to $25,000.

The same material may be moved to the central sand-mixing plant and returned to the molding floors with a grab bucket costing less than $3000 fully equipped with accessories except crane. The material may be moved during one hour following the heat and returned one hour before the starting time the following day at a cost not over $0.025 per ton of sand.

Additional Uses of Bucket

In addition the bucket may be used throughout the day for filling large molds, for excavating pits and for unloading incoming coke, coal and sand. A detail view of the Hayward bucket is shown in Fig. 11. This bucket is entirely controlled from the cage of the traveling crane.

The most undesirable and dirty part of the day's work in the foundry is dumping out castings, and for this work a magnet may be used with economical and satisfactory results, as shown in Figs. 13 and 14. Figs. 16



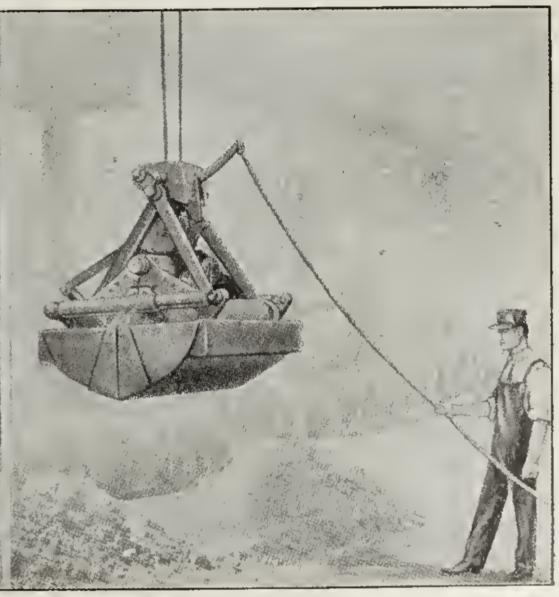


FIG. 8—CUTTING AND MIXING SAND WITH BUCKET. FIG. 9—GRAB BUCKET READY TO BE TRIPPED

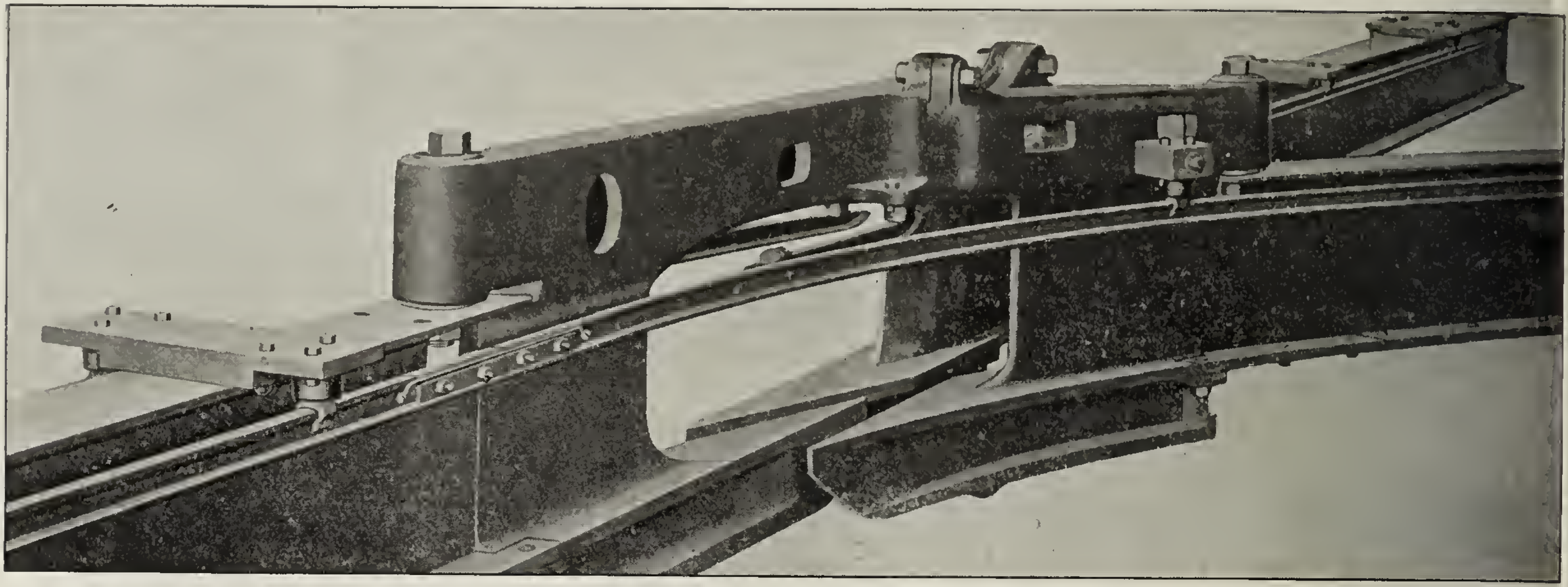


FIG. 10—FIXED TONGUE TRACK SWITCH FOR MONORAIL TRACK

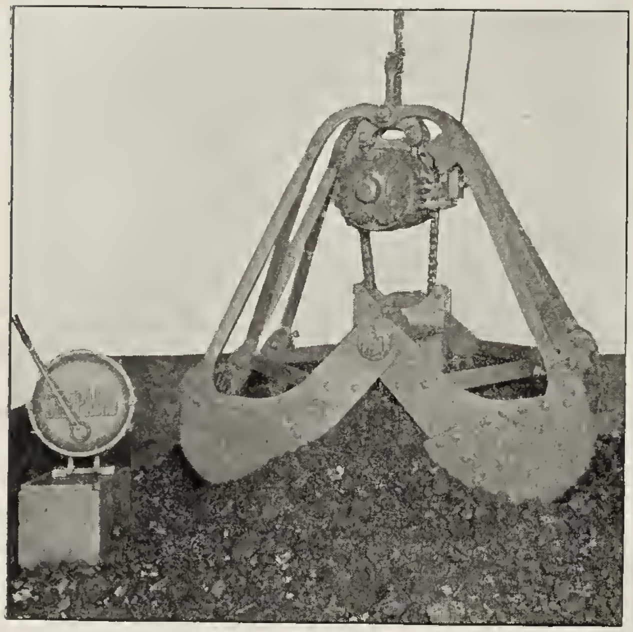


FIG. 11—MOTOR GRAB BUCKET HANDLING COAL

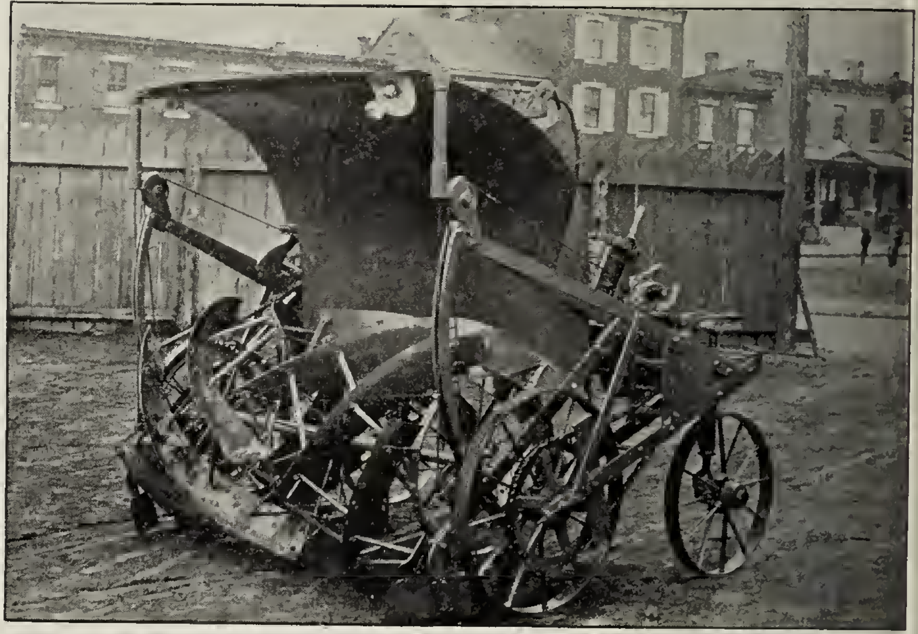


FIG. 12—SAND CUTTING MACHINE

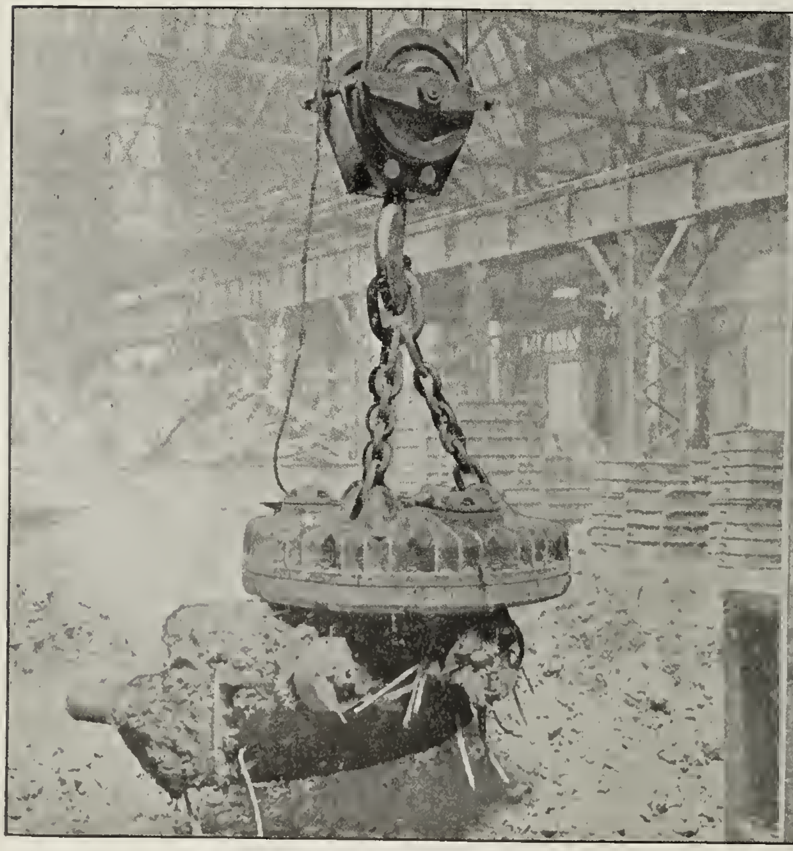


FIG. 13—HANDLING HOT CASTINGS WITH MAGNET AFTER SHAKING-OUT

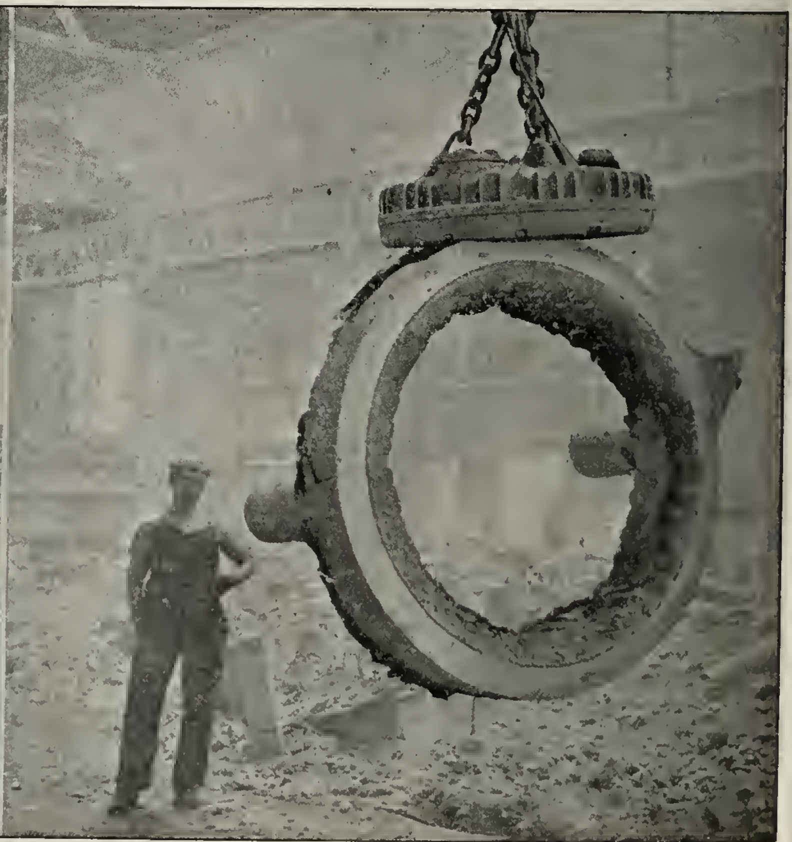


FIG. 14—CARRYING HOT CASTING WITH MAGNET TO CLEANING FLOOR

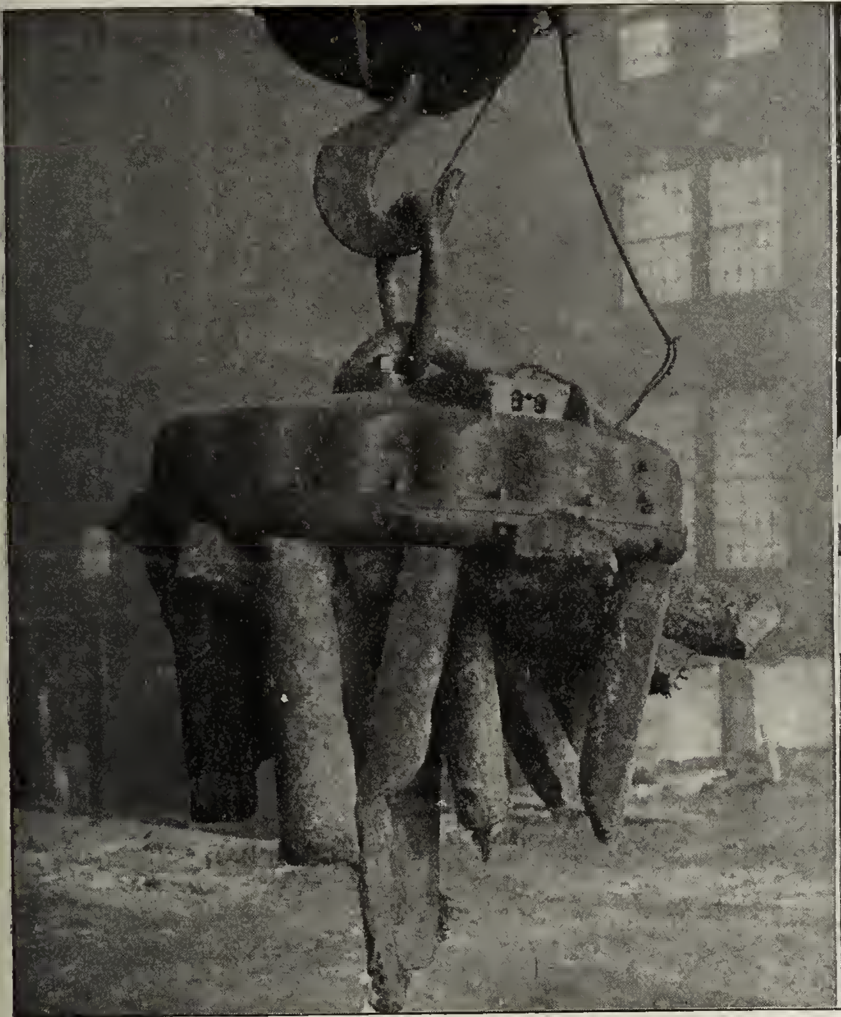


FIG. 15—HANDLING PIG IRON WITH A 43-INCH MAGNET

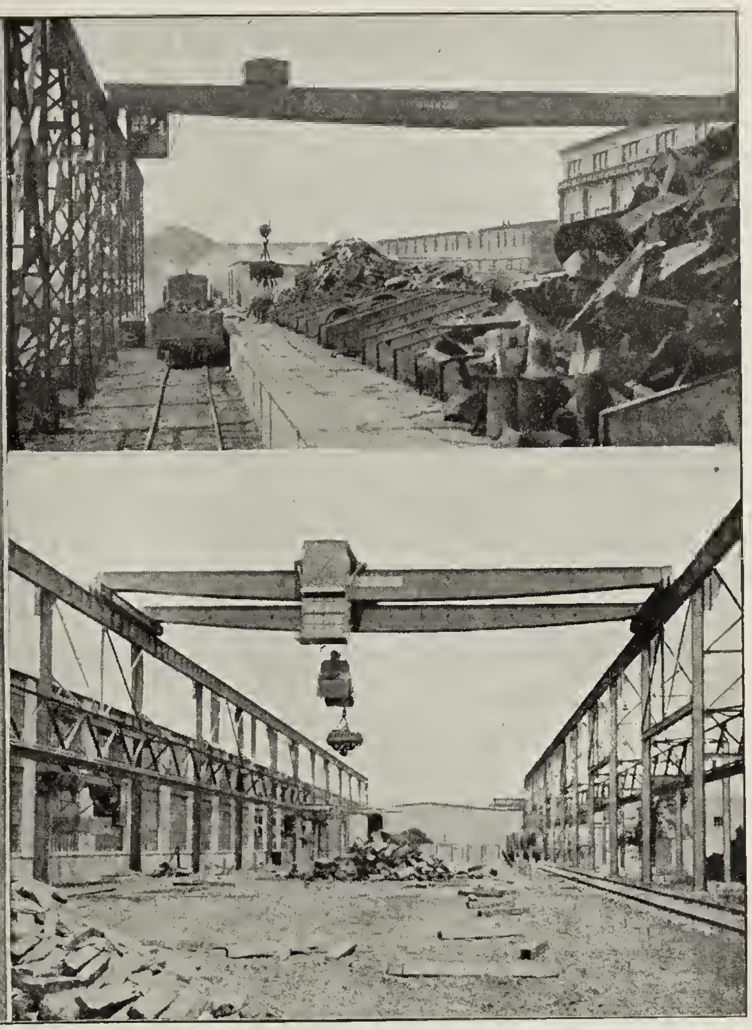


FIG. 16—UNLOADING PIG IRON WITH 62-INCH MAGNET. FIG. 17—TRAVELING YARD CRANE EQUIPPED WITH 62-INCH MAGNET

and 17 show traveling cranes applied to yard work; in one instance both buckets and magnets are shown, indicating the ease with which material is here handled.

Jib or bracket cranes are of great value and relieve the overhead traveling cranes. Especially are they convenient and valuable when used in connection with the setting of cores. These cranes may be made to cover a large area, handling the work for several floors, and can be erected on any wall or post and may be swung out of the way of any work on the floor. They may be equipped with geared triplex blocks, air or electric hoists. Figs. 18 and 19 show views of electric and air hoists.

Fig. 22 illustrates a monorail system manufactured by the Shaw Electric Crane Co., Muskegon, Mich., applied in a portion of the J. I. Case Threshing Machine Co.'s foundry at Racine, Wis. In this system each monorail transfer bridge is equipped with a monorail hoist. This bridge is equipped with a latching device which is operated from the hoist cage. The entire unit may be operated as a three-motor traveling overhead crane. The controller for the bridge is placed in the hoist cage so that the bridge can be controlled from the cage. When it is desired to engage a spur track to allow the hoist to run off the bridge, the bridge is latched securely to the track before the hoist is run off. When the crane is engaged with

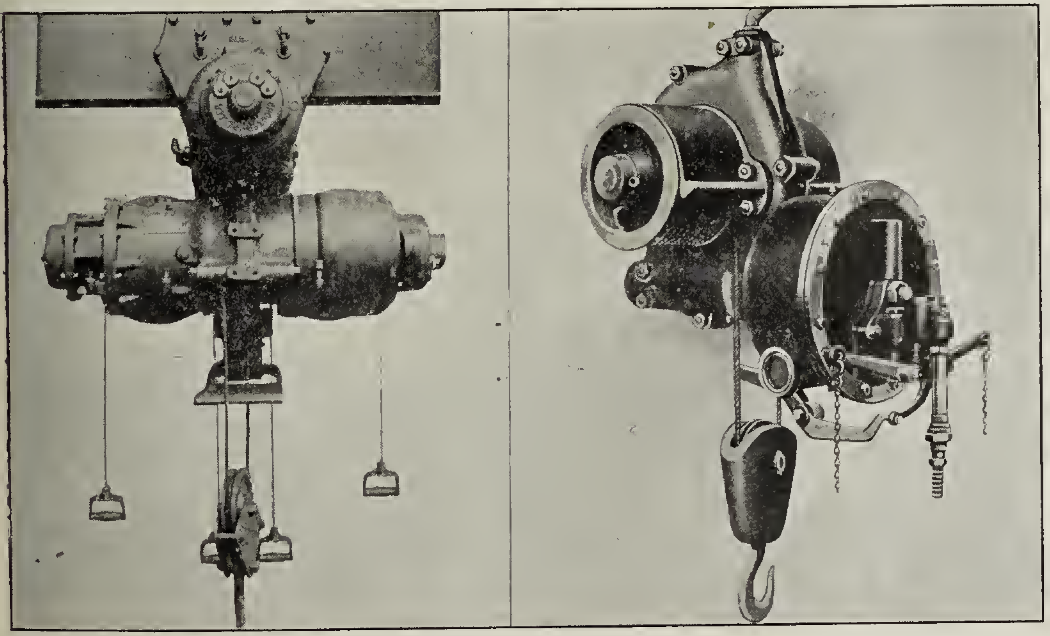


FIG. 18—ELECTRIC HOIST FOR SMALL LOADS. FIG. 19—AIR HOIST 2000 POUNDS CAPACITY

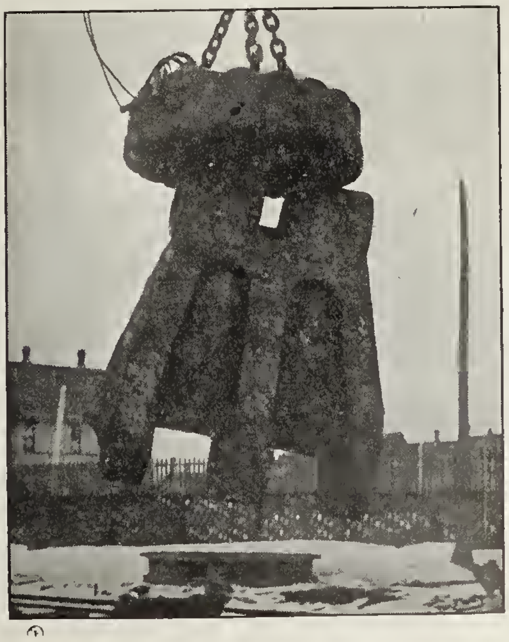
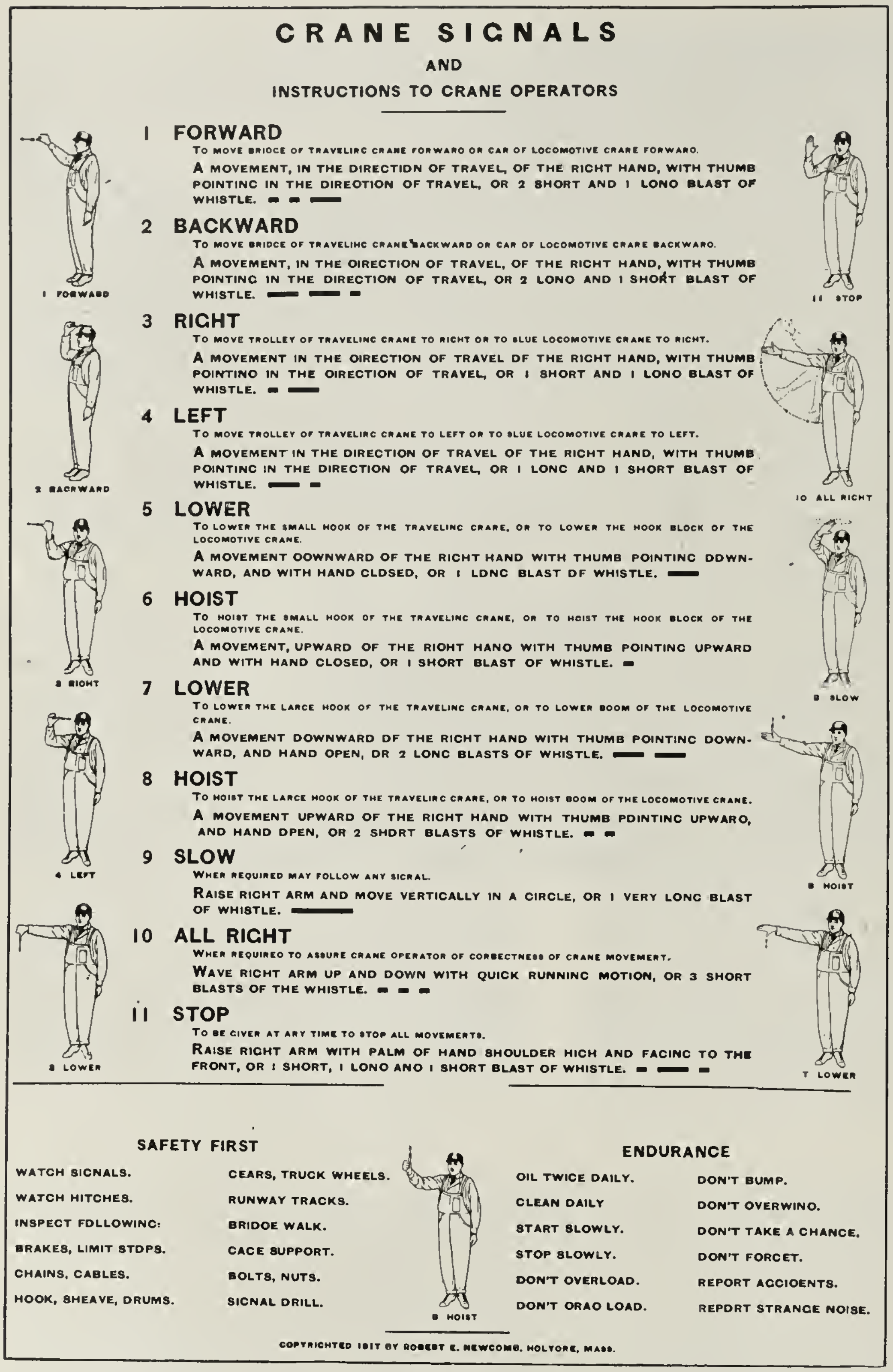


FIG. 20—3500-POUND CASTING HANDLED BY MAGNET


1 FORWARD
11 STOP
2 BACKWARD
10 ALL RIGHT
3 RIGHT
9 SLOW
4 LEFT
8 HOIST
5 LOWER
7 LOWER
6 HOIST

CRANE SIGNALS
AND
INSTRUCTIONS TO CRANE OPERATORS

1 FORWARD

TO MOVE BRIDGE OF TRAVELING CRANE FORWARD OR CAR OF LOCOMOTIVE CRANE FORWARD.

A MOVEMENT, IN THE DIRECTION OF TRAVEL, OF THE RIGHT HAND, WITH THUMB POINTING IN THE DIRECTION OF TRAVEL, OR 2 SHORT AND 1 LONG BLAST OF WHISTLE. ▪ ▪ ▬

2 BACKWARD

TO MOVE BRIDGE OF TRAVELING CRANE BACKWARD OR CAR OF LOCOMOTIVE CRANE BACKWARD.

A MOVEMENT, IN THE DIRECTION OF TRAVEL, OF THE RIGHT HAND, WITH THUMB POINTING IN THE DIRECTION OF TRAVEL, OR 2 LONG AND 1 SHORT BLAST OF WHISTLE. ▬ ▬ ▪

3 RIGHT

TO MOVE TROLLEY OF TRAVELING CRANE TO RIGHT OR TO SLUE LOCOMOTIVE CRANE TO RIGHT.

A MOVEMENT IN THE DIRECTION OF TRAVEL OF THE RIGHT HAND, WITH THUMB POINTING IN THE DIRECTION OF TRAVEL, OR 1 SHORT AND 1 LONG BLAST OF WHISTLE. ▪ ▬

4 LEFT

TO MOVE TROLLEY OF TRAVELING CRANE TO LEFT OR TO SLUE LOCOMOTIVE CRANE TO LEFT.

A MOVEMENT IN THE DIRECTION OF TRAVEL OF THE RIGHT HAND, WITH THUMB POINTING IN THE DIRECTION OF TRAVEL, OR 1 LONG AND 1 SHORT BLAST OF WHISTLE. ▬ ▪

5 LOWER

TO LOWER THE SMALL HOOK OF THE TRAVELING CRANE, OR TO LOWER THE HOOK BLOCK OF THE LOCOMOTIVE CRANE.

A MOVEMENT DOWNWARD OF THE RIGHT HAND WITH THUMB POINTING DOWNWARD, AND WITH HAND CLOSED, OR 1 LONG BLAST OF WHISTLE. ▬

6 HOIST

TO HOIST THE SMALL HOOK OF THE TRAVELING CRANE, OR TO HOIST THE HOOK BLOCK OF THE LOCOMOTIVE CRANE.

A MOVEMENT, UPWARD OF THE RIGHT HAND WITH THUMB POINTING UPWARD AND WITH HAND CLOSED, OR 1 SHORT BLAST OF WHISTLE. ▪

7 LOWER

TO LOWER THE LARGE HOOK OF THE TRAVELING CRANE, OR TO LOWER BOOM OF THE LOCOMOTIVE CRANE.

A MOVEMENT DOWNWARD OF THE RIGHT HAND WITH THUMB POINTING DOWNWARD, AND HAND OPEN, OR 2 LONG BLASTS OF WHISTLE. ▬ ▬

8 HOIST

TO HOIST THE LARGE HOOK OF THE TRAVELING CRANE, OR TO HOIST BOOM OF THE LOCOMOTIVE CRANE.

A MOVEMENT UPWARD OF THE RIGHT HAND WITH THUMB POINTING UPWARD, AND HAND OPEN, OR 2 SHORT BLASTS OF WHISTLE. ▪ ▪

9 SLOW

WHEN REQUIRED MAY FOLLOW ANY SIGNAL.

RAISE RIGHT ARM AND MOVE VERTICALLY IN A CIRCLE, OR 1 VERY LONG BLAST OF WHISTLE. ▬▬▬

10 ALL RIGHT

WHEN REQUIRED TO ASSURE CRANE OPERATOR OF CORRECTNESS OF CRANE MOVEMENT.

WAVE RIGHT ARM UP AND DOWN WITH QUICK RUNNING MOTION, OR 3 SHORT BLASTS OF THE WHISTLE. ▪ ▪ ▪

11 STOP

TO BE GIVEN AT ANY TIME TO STOP ALL MOVEMENTS.

RAISE RIGHT ARM WITH PALM OF HAND SHOULDER HIGH AND FACING TO THE FRONT, OR 1 SHORT, 1 LONG AND 1 SHORT BLAST OF WHISTLE. ▪ ▬ ▪

SAFETY FIRST

WATCH SIGNALS.
WATCH HITCHES.
INSPECT FOLLOWING:
BRAKES, LIMIT STOPS.
CHAINS, CABLES.
HOOK, SHEAVE, DRUMS.
GEARS, TRUCK WHEELS.
RUNWAY TRACKS.
BRIDGE WALK.
CAGE SUPPORT.
BOLTS, NUTS.
SIGNAL DRILL.

ENDURANCE

OIL TWICE DAILY.
CLEAN DAILY
START SLOWLY.
STOP SLOWLY.
DON'T OVERLOAD.
DON'T DRAG LOAD.
DON'T BUMP.
DON'T OVERWIND.
DON'T TAKE A CHANCE.
DON'T FORGET.
REPORT ACCIDENTS.
REPORT STRANGE NOISE.

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FIG. 21—CRANE SIGNALS AND INSTRUCTIONS FOR CRANE OPERATORS

any of the spur tracks, all other tracks are locked by baffle plates, thus preventing any other hoist running out into the crane bay. When the bridge engages the spur track this baffle is automatically lifted, allowing the hoist to immediately run onto the bridge.

All gearing, with the exception of the truck gears, is enclosed in heavy dust-tight cases and is oil bath lubricated. The bridge is equipped with an electric brake, which automatically stops the travel of the bridge when the power is cut off from the traveling motor. This machine can be installed in the central bay with spurs leading to other parts of the plant and to unloading platform thus allowing flexibility in the operation and use of a monorail hoist. A unique feature of the system is said to be the fixed tongue switch.

The operation of this switch is such that under no conditions can it present an open end to the trolley, thus eliminating the possibility of an accidental derailment. Furthermore, this track-switch does not have to be set for the desired directions of travel; the operator does not have to stop and reach out to "throw" the switch. He selects his route by pulling a lever in the operating cage as he approaches the switch in the manner to be described. The trolley, therefore, runs through the track switch in any direction without stopping, thus avoiding all loss of time at the switches.

Considering the track layout, it is apparent that the introduction of a track-switch of the moving-tongue type impairs the continuity of the main track, since the track-switch may at any time be set for the spur track —a contingency for which the operator must be constantly on the alert. With the fixed-tongue system, on the other hand, both routes through the track-switch are always free. For these reasons it is entirely practicable to lay out a track system with as many track-switches of the fixed-tongue type as may be required, located wherever there is occasion to divide or divert the traffic, whereas with the moving tongue type, the introduction of track-switches is restricted by practical operating considerations.

Referring to Fig. 10, it will be seen that the steel castings composing

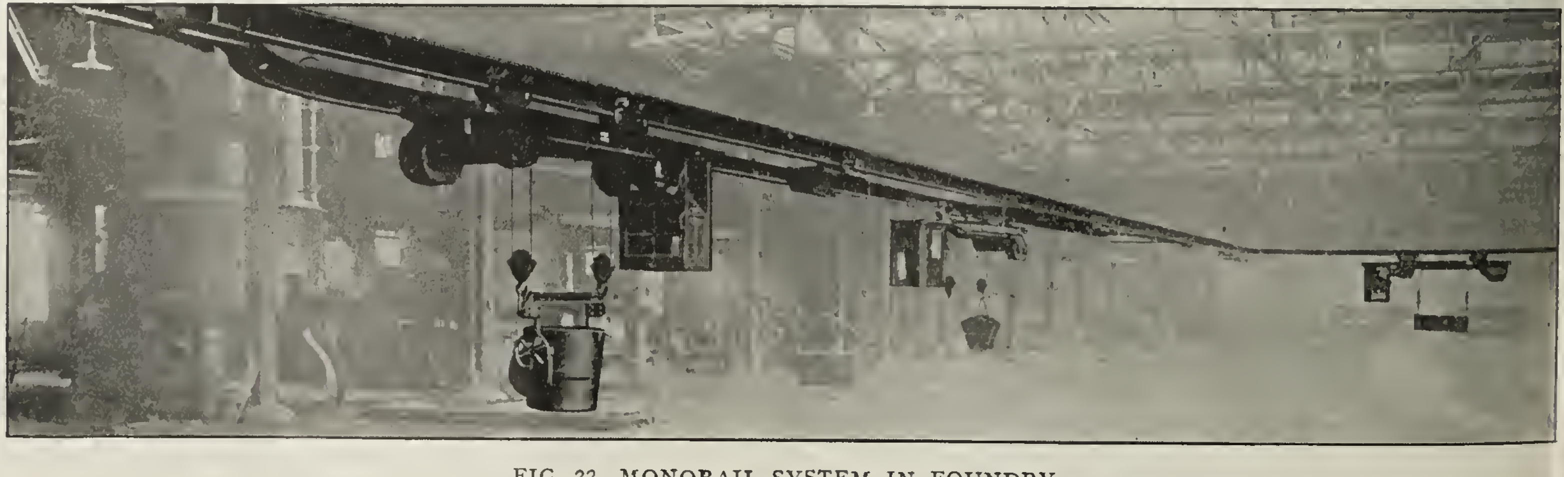
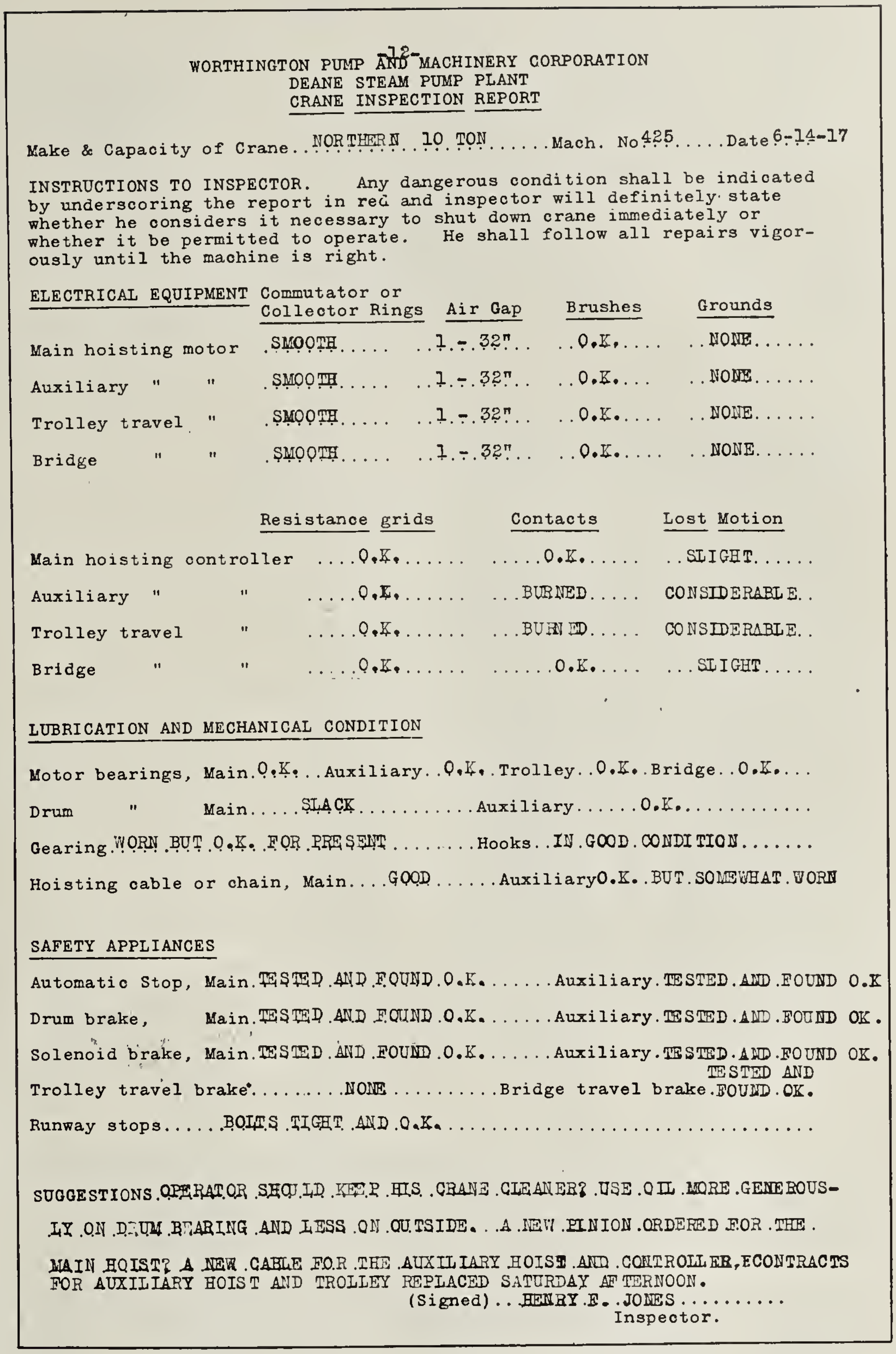


FIG. 22—MONORAIL SYSTEM IN FOUNDRY



-12-

WORTHINGTON PUMP AND MACHINERY CORPORATION
DEANE STEAM PUMP PLANT
CRANE INSPECTION REPORT

Make & Capacity of Crane..NORTHERN 10 TON.....Mach. No425....Date6-14-17

INSTRUCTIONS TO INSPECTOR. Any dangerous condition shall be indicated by underscoring the report in red and inspector will definitely state whether he considers it necessary to shut down crane immediately or whether it be permitted to operate. He shall follow all repairs vigorously until the machine is right.

ELECTRICAL EQUIPMENT	Commutator or Collector Rings	Air Gap	Brushes	Grounds
Main hoisting motor	.SMOOTH....	..1.-.32"..	..O.K....	..NONE......
Auxiliary " "	.SMOOTH....	..1.-.32"..	..O.K....	..NONE......
Trolley travel "	.SMOOTH....	..1.-.32"..	..O.K....	..NONE......
Bridge " "	.SMOOTH....	..1.-.32"..	..O.K....	..NONE......

	Resistance grids	Contacts	Lost Motion
Main hoisting controller	....O.K......	.....O.K.....	..SLIGHT.....
Auxiliary " "	.....O.K......	...BURNED.....	CONSIDERABLE..
Trolley travel "	.....O.K......	...BURNED.....	CONSIDERABLE..
Bridge " "	.....O.K......	......O.K....	...SLIGHT.....

LUBRICATION AND MECHANICAL CONDITION

Motor bearings, Main.O.K...Auxiliary..O.K..Trolley..O.K..Bridge..O.K....

Drum " Main....SLACK...........Auxiliary......O.K.............

Gearing.WORN.BUT.O.K..FOR.PRESENT........Hooks..IN.GOOD.CONDITION.......

Hoisting cable or chain, Main...GOOD......AuxiliaryO.K..BUT.SOMEWHAT.WORN

SAFETY APPLIANCES

Automatic Stop, Main.TESTED.AND.FOUND.O.K......Auxiliary.TESTED.AND.FOUND O.K

Drum brake, Main.TESTED.AND.FOUND.O.K......Auxiliary.TESTED.AND.FOUND OK.

Solenoid brake, Main.TESTED.AND.FOUND.O.K......Auxiliary.TESTED.AND.FOUND OK.

Trolley travel brake.........NONE..........Bridge travel brake.TESTED AND FOUND.OK.

Runway stops.....BOLTS.TIGHT.AND.O.K...............................

SUGGESTIONS.OPERATOR.SHOULD.KEEP.HIS.CRANE.CLEANER? USE.OIL.MORE.GENEROUSLY.ON.DRUM.BEARING.AND.LESS.ON.OUTSIDE...A.NEW.PINION.ORDERED.FOR.THE.MAIN.HOIST? A.NEW.CABLE.FOR.THE.AUXILIARY.HOIST.AND.CONTROLLER,ECONTRACTS FOR AUXILIARY HOIST AND TROLLEY REPLACED SATURDAY AFTERNOON.

(Signed)..HENRY.F..JONES..........
Inspector.

FIG. 23—REPORT OF CRANE INSPECTION

the track-switch are formed with tread flange to correspond with those of the track beam and that these tread flanges are divided into three tongues by the two slots. The trolley has two four-wheel swivel trucks and as it runs through the track-switch one side of each truck passes through one of the switch slots, while the wheels successively cross the other slot. It should be particularly noted that in consequence of the angular position of the slot with reference to the direction of travel, wheels directly opposite each other in the truck do not cross simultaneously and that there are always two diagonally opposite wheels in proper position to carry the load. As the truck runs through the switch, therefore, the action is the same as if the track were continuous.

Selecting the Route

The manner in which the leading truck is steered onto the spur track is shown in Fig. 24, which is a sectional plan at the level of the lower flange of the I-beam, showing a right hand track-switch and the truck sides of the trolley. When approaching the track-switch with the intention of running onto the spur track, the horizontal roller T_2, located in front of the leading truck and known as the steering tappet, is raised by the steering lever in the cage and engages the curved flange *B* on the under side of the central tongue of the track-switch. In this manner the leading truck is swiveled and diverted onto the spur track. No steering operation is necessary to return from the spur track to the main track, nor to run through the track-switch in either direction on the main line.

The means whereby the rear truck is compelled to follow the leading truck onto the spur track is indicated in Fig. 25, the main portion of which corresponds to Fig. 24, while the auxiliary portion is a section (drawn to a larger scale) showing the rear truck and a portion of the trolley frame. Lines *L*, *R* and *F* are the center lines respectively of the leading truck, the rear truck and the trolley frame. When on a curve, the trucks swivel relative to the trolley frame, through an angle denominated *A* in the case of the rear truck and, as indicated in the auxiliary

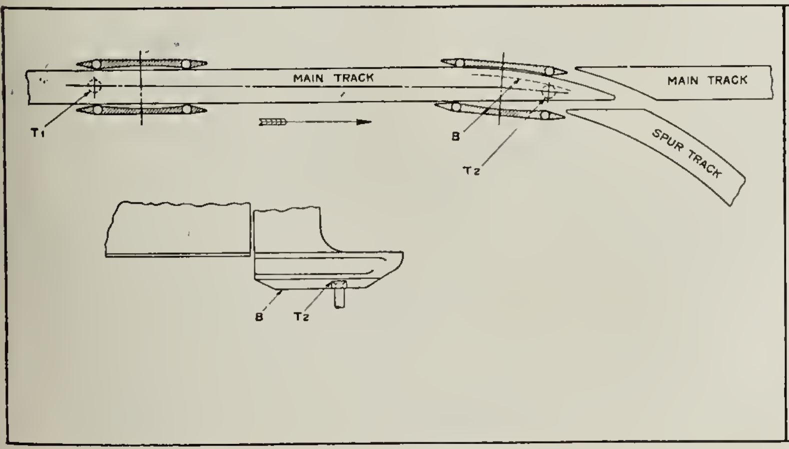


FIG. 24—STEERING THE LEADING TRUCK ON THE SPUR TRACK

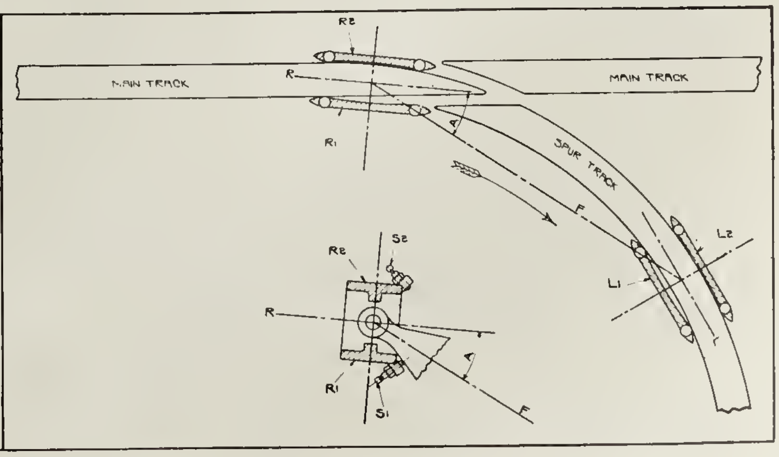
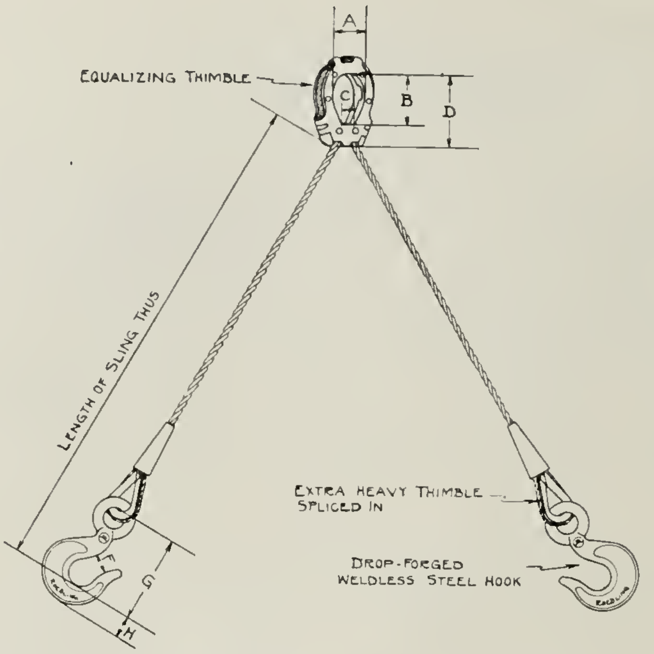


FIG. 25—METHOD OF STEERING THE REAR TRUCK ON THE SPUR TRACK

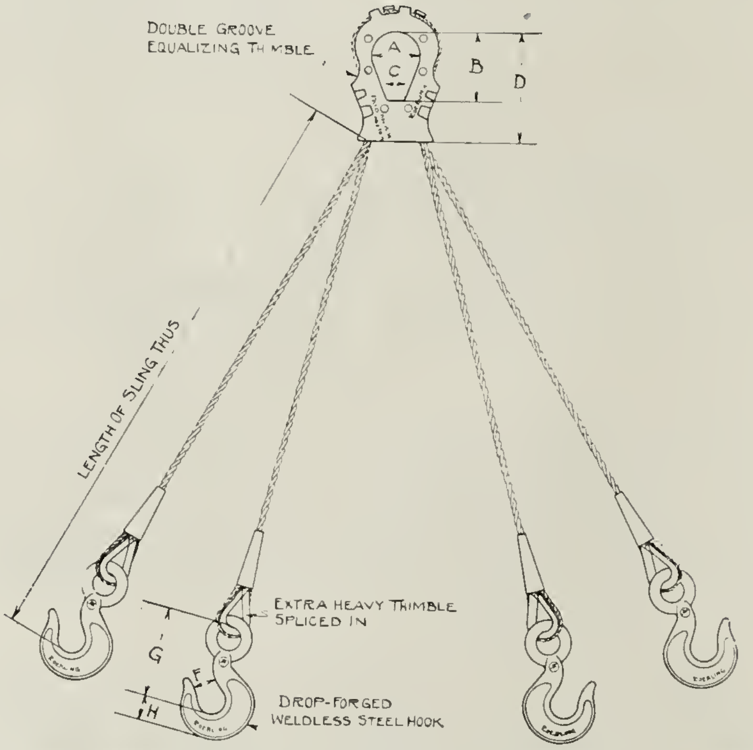

A
B
C
D
EQUALIZING THIMBLE
LENGTH OF SLING THUS
EXTRA HEAVY THIMBLE SPLICED IN
DROP-FORGED WELDLESS STEEL HOOK
F
G
H

MAXIMUM SAFE LOADS, ETC.

WHERE ROPE DOES NOT COME IN CONTACT WITH THE MATERIAL HOISTED AS SHOWN IN FIG 1, PER "CS-168." SAFE LOADS IN TONS OF 2,000 LBS

DIAM. SLING	SAFE LOADS		HOOK				EQUALIZING THIMBLES											
							SET "M"				SET "L"				SET "SP"			
	WHEN USED VERTICAL	WHEN USED 60° ANGLE	SIZE HOOK	F	G	H	A	B	C	D	A	B	C	D	A	B	C	D
1/2"	3	2.5	25	1 1/2"	5 7/16"	1 9/16"	3 7/8"	5 1/2"	1 1/4"	7 3/4"								
5/8	4.5	4	30.	1 5/8	6 5/16	1 3/4	3 7/8	5 3/4	1 3/8	8 3/8								
3/4	6.25	5.5	40	1 7/8	7 1/2	2	3 7/8	5 3/4	1 3/8	8 3/8					8	12	1 7/8	15
7/8	9	8	50	2 1/8	8 7/16	2 5/16	5 1/4	8	1 1/4	10 1/4	6 5/8	10 1/4	1 15/16	13	8	12	1 7/8	15
1	11.5	10	65	2 7/16	9 1/2	2 9/16	5 1/4	8	1 1/4	10 1/4	6 5/8	10 1/4	1 15/16	13	8 1/2	13	2 1/16	16
1 1/8	14	12	75	2 9/16	10 5/16	2 3/4	5 1/4	7 3/4	1 1/2	10 1/2	7	10 5/8	2	13 5/8	8 1/2	13	2 1/16	16
1 1/4	17	14.5	90	3	11 11/16	3	5 1/4	7 3/4	1 1/2	10 1/2	7	10 5/8	2	13 5/8	8 1/2	13	2 1/8	16 1/4
1 3/8	20	17	110	3 5/16	12 7/16	3 1/8	6	9 3/4	1 3/4	13	8 1/2	13	2 1/8	16 1/4				
1 1/2	23	20	125	3 3/4	13 5/8	3 1/2	6	9 3/4	1 3/4	13	8 1/2	13	2 1/8	16 1/4				
1 5/8	25	22	150	4 1/2	15 1/2	4	9	14	2	17 3/4								
1 3/4	29	25	175	5	18	4 3/4	9 3/4	15	2 1/2	19 1/2								

EQUALIZING BRIDLE SLINGS WITH HOOKS
"BLUE CENTER STEEL" ROPE

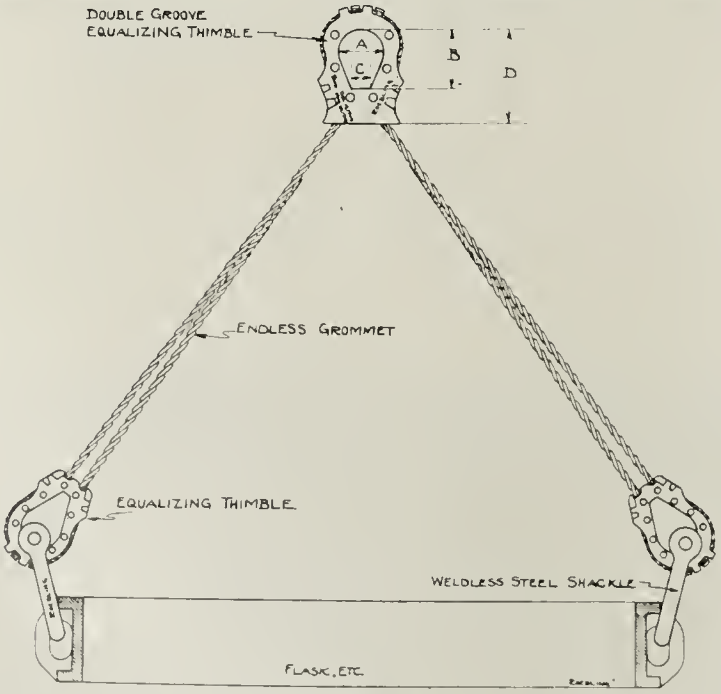

DOUBLE GROOVE EQUALIZING THIMBLE
A
B
C
D
LENGTH OF SLING THUS
EXTRA HEAVY THIMBLE SPLICED IN
G
F
H
DROP-FORGED WELDLESS STEEL HOOK

MAXIMUM SAFE LOADS
IN TONS OF 2,000 LBS.

WHERE ROPE DOES NOT COME IN CONTACT WITH THE MATERIAL HOISTED SIMILAR TO SLING FIG 1, PER "CS-168.

DIAM SLING	SAFE LOADS IN TONS		THIMBLE				HOOK			
	WHEN USED 60° ANGLE	WHEN USED 45° ANGLE	A	B	C	D	SIZE HOOK	F	G	H
1/2"	5	4.25	5 1/4"	7 1/4"	2"	11 1/4"	25	1 1/2"	5 7/16"	1 9/16"
5/8	8	6.5	5 1/4	7 1/2	1 15/16	11 7/8	30	1 5/8	6 5/16	1 3/4
3/4	11	9	5 1/4	7 1/2	1 15/16	11 7/8	40	1 7/8	7 1/2	2
7/8	16	12.5	6 1/2	8 3/4	2 3/8	14 1/4	50	2 1/8	8 7/16	2 5/16
1	20	16	6 1/2	8 3/4	2 3/8	14 1/4	65	2 7/16	9 1/2	2 9/16
1 1/8	24	20	8	11 1/4	2 5/8	17 3/4	75	2 9/16	10 5/16	2 3/4
1 1/4	29	24	8	11 1/4	2 5/8	17 3/4	90	3	11 11/16	3
1 3/8	34	28	9	12	3 1/2	19	110	3 5/16	12 7/16	3 1/8
1 1/2	40	32	9	12	3 1/2	19	125	3 3/4	13 5/8	3 1/2
1 5/8	44	35	10	13	4 3/8	20 1/2	150	4 1/2	15 1/2	4
1 3/4	50	41	10	13	4 3/8	20 1/2	175	5	18	4 3/4

EQUALIZING BRIDLE SLINGS WITH FOUR HOOKS
"BLUE CENTER STEEL" ROPE



MAXIMUM SAFE LOADS

WHERE ROPE DOES NOT COME IN CONTACT WITH THE MATERIAL HOISTED AS SHOWN WITH SLING HITCHED TO FLASK. FOR HOISTING UNDER MORE ADVERSE CONDITIONS, SEE B/P "CS-149."

DIAM SLING	SAFE LOAD IN TONS OF 2000 LBS			THIMBLE			
	WHEN USED VERTICAL	WHEN USED 60° ANGLE	WHEN USED 45° ANGLE	A	B	C	D
1/2"	6	5	4	5 1/4"	7 1/4"	2"	11 1/4"
5/8	10	8.5	7	5 1/4	7 1/2	1 15/16	11 7/8
3/4	14	12	10	5 1/4	7 1/2	1 15/16	11 7/8
7/8	20	17	14	6 1/2	8 3/4	2 3/8	14 1/4
1	26	22.5	18	6 1/2	8 3/4	2 3/8	14 1/4
1 1/8	32	28	23	8	11 1/4	2 5/8	17 3/4
1 1/4	38	33	27	8	11 1/4	2 5/8	17 3/4
1 3/8	45	39	32	9	12	3 1/2	19
1 1/2	51	44	36	9	12	3 1/2	19
1 5/8	57	49	40	10	13	4 3/8	20 1/2
1 3/4	65	56	46	10	13	4 3/8	20 1/2

NOTE:– SHACKLES ARE DESIGNED TO SUIT MEMBER HOISTED

SHACKLE BRIDLE SLINGS
GROMMET CONSTRUCTION
"BLUE CENTER STEEL" ROPE

FIG. 26—TABLE OF SAFE LOADS OF BRIDLE SLINGS ISSUED BY JOHN A. ROEBLING'S SONS CO. FIG. 27—SAFE LOADS OF BRIDLE SLINGS WITH FOUR HOOKS. FIG. 28—SAFE LOADS OF BRIDLE SLINGS WITH EQUALIZING THIMBLE AND SHACKLE CONNECTIONS

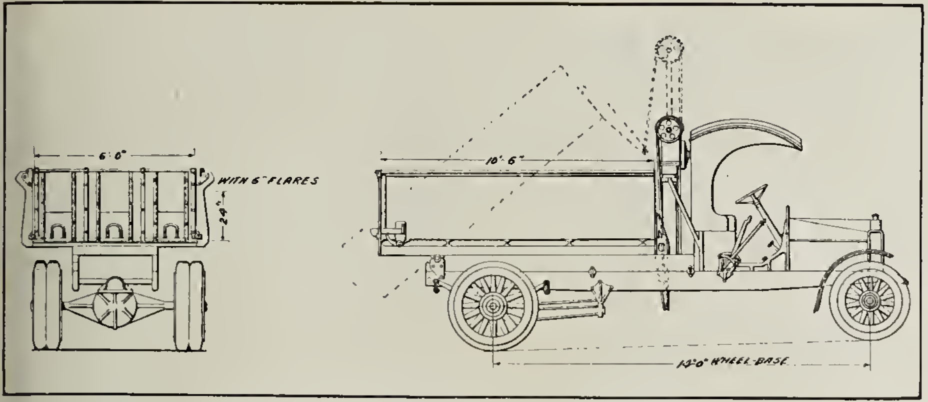


FIG. 29—TRUCK WITH STEEL DUMP BODY AND HYDRAULIC HOIST

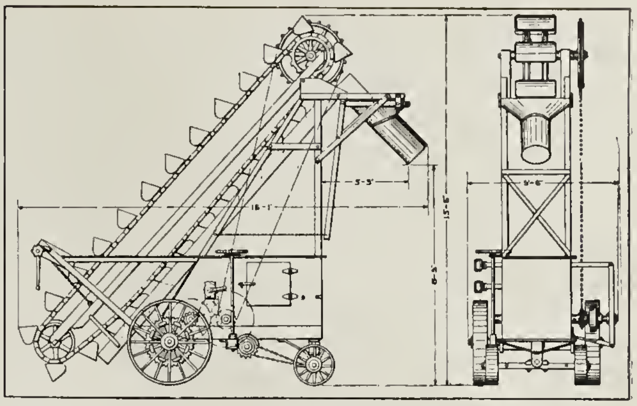


FIG. 30—TRUCK LOADER FOR CRUSHED STONE, SAND AND SIMILAR MATERIALS

diagram, angle A is limited by an adjustable set-screw S_1 in the trolley side R_1. Assuming both trucks to be on the main track and approaching the track-switch, the center lines L, R and F would then lie in a straight line and angle A would be zero. As the leading truck proceeds around the curve of the spur, the trolley frame swings around with reference to center line R of the rear truck and angle A increases. When the rear truck reached the point where the curve begins (approximately the position shown in Fig. 25) the frame castings engage the set-screw S_1 and angle A has attained its maximum value. As the trolley proceeds further, the frame castings slews the rear truck around and compels it to follow onto the spur track.

The diagram shows a right-hand switch, but it will be noted that set-screws S_2 in the truck side R_2 provides for the left-hand switches. It is, of course, also understood that the trolley travels either end ahead and that both trucks embody the steering feature and the set-screws.

Unloading sand and the disposal of foundry refuse is an important item in the cost of operating a foundry and may be frequently reduced by the use of a locomotive crane. A locomotive crane of 15-ton capacity at about 15-foot radius and 5-ton at about 42-foot radius is adapted for a foundry of 50-ton daily capacity. A purchaser should invariably purchase an 8-wheel crane mounted on a specially constructed, exceptionally heavy truck built of structural steel shapes and conforming to Master Car Builders' specifications. Such a machine will cost in normal times about $12,000, at present $18,000, and should be equipped with the following additionals:

One yard chain bucket..............	$ 800.00
One 45-inch magnet................	1400.00
7½-kilowatt turbine generator.......	800.00

A locomotive crane and grab bucket, as shown in Fig. 1, illustrating a Brown Hoisting Machine Co. loco-

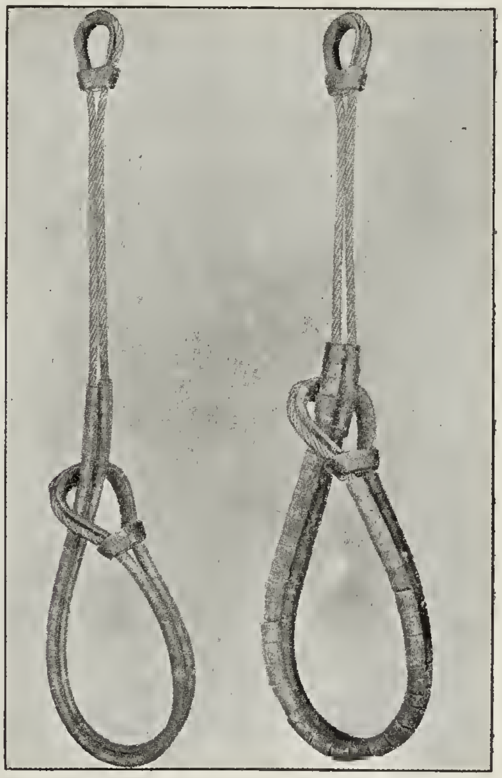


FIG. 32—TWO TYPES OF PROTECTED ANCHOR SLINGS

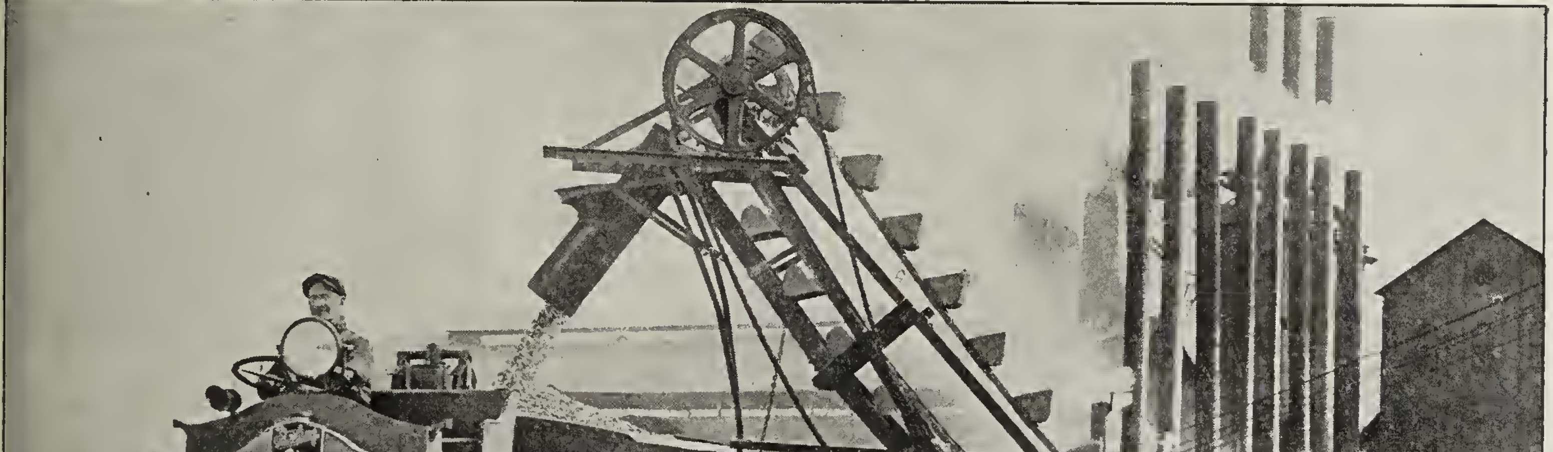


FIG. 31—PORTABLE WAGON LOADER, CAPACITY ONE TON PER MINUTE

motive crane and bucket, can unload a 40-ton carload of sand in 30 minutes. The same equipment may also be used for unloading coal and coke at a considerable saving over the usual hand methods. A 40-ton carload of pig iron or scrap may be unloaded in 50 to 60 minutes with a locomotive crane equipped with a lifting magnet. Figs. 15 and 20 show other representative views of lifting magnets used in connection with cranes. These figures illustrate the obvious saving resulting from the use of lifting magnets in connection with the locomotive and traveling cranes.

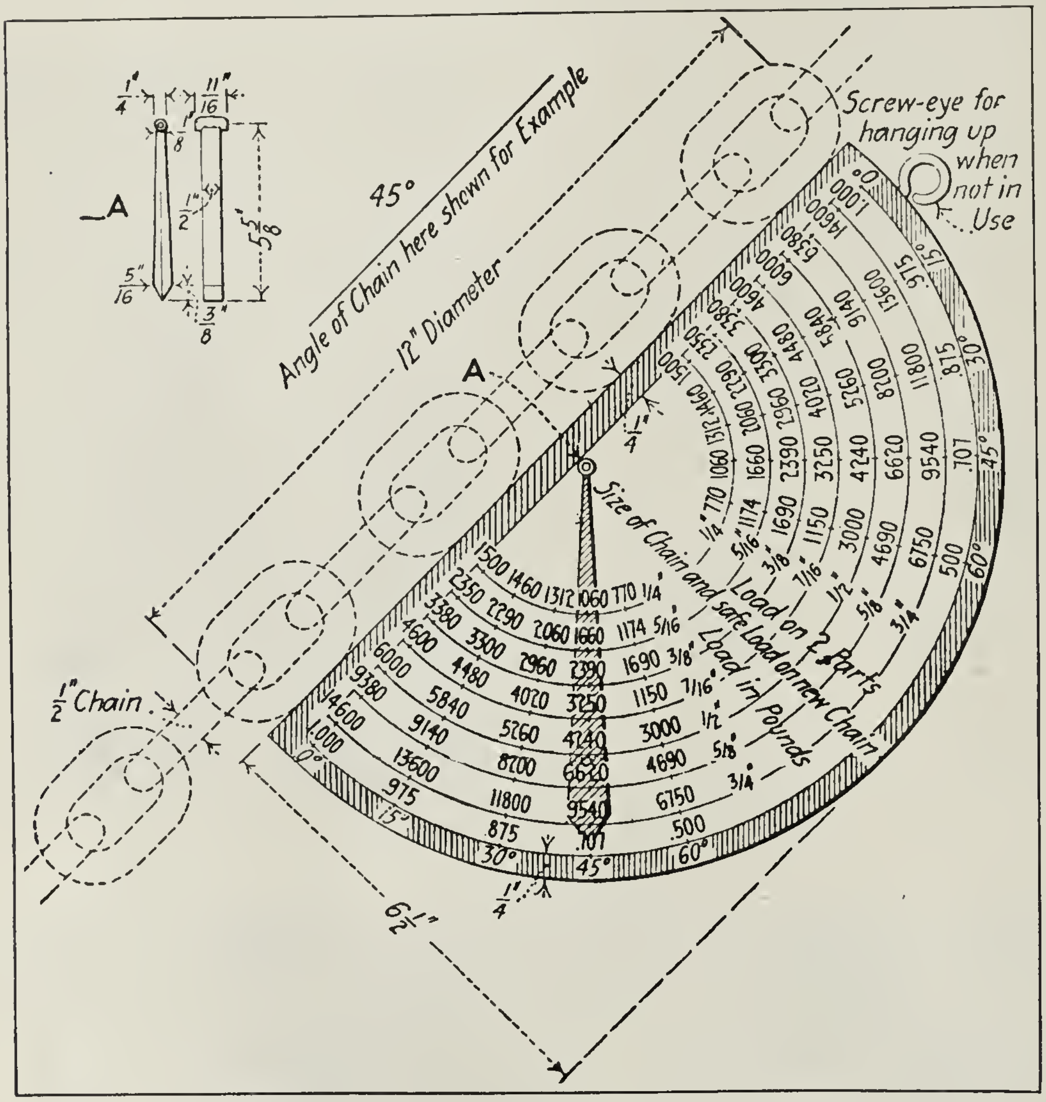

45°
Angle of Chain here shown for Example
12" Diameter
Screw-eye for hanging up when not in Use
A
1/2" Chain
Size of Chain and safe Load on 2 Parts
Load on new Chain
Safe Load in Pounds
6 1/2"
0°
15°
30°
45°
60°

FIG. 33—SAFE-LOAD GAGE FOR CHAIN AND ROPE SLINGS

Crane Operation and Maintenance

The use of cranes and hoisting devices require careful thought and attention. All chains and cables should be inspected regularly and carefully for flaws or defects. Sling chains of suitable strength should always be used. Selection is usually left to the judgment of the employe making the hitch. A method to train him and provide him with information so that he will know just what he is doing was devised by F. W. Salmon and described as follows in the *American Machinist* of Jan. 16, 1916:

"The illustration (Fig. 33) shows a gage by which the safe load on a chain or wire-rope sling may be obtained for any angle of sling from the vertical to 60 degrees, by either placing the gage against the sling, as shown, or holding it at a distance at such an angle that its upper edge coincides with the axis of the sling part. It is suitable for all the usual sizes of chain or wire rope, provided they are in good condition.

"It is simply a light, seasoned-wood frame *A*, about 1 foot long and 3/4 inch thick, cut out on a jig-saw. In the center of this frame is freely suspended a small, heavy pendulum. Transparent celluloid is put on each side of the frame, and on this are marked the graduations for the safe loads for chains on one side, for ropes on the other.

"The very fact that such an instrument is in the shop and frequently used will lead the men to be more careful, give them a better idea of the effect of the angles on sling chains, and lead them to become better informed on the strength of slings and the weights of the pieces commonly lifted."

At the Deane works of the Worthington Pump & Machinery Corp., each sling is marked with its capacity, and this with other similar precautionary measures has established a record of no serious accidents from the use of hoisting apparatus. Figs. 26, 27 and 28 are reproduced from John A. Roebling's Son catalog and give similar data with the reference to the use of steel rope slings. Fig. 32 shows a type of sling in which the wire is armored or protected against direct contact with the object lifted.

Sometimes a frequent and just criticism of many molders is inadequate and poor crane service. Crane service may be improved by the use of standard signals and suitable instructions to crane operators. As a suggestion, the crane signals in use at the Deane works of the Worthington Pump & Machinery Corp., shown in Fig. 36, are submitted.

Another cause of improper service of cranes is their frequent stoppage for repairs. Cranes constructed and designed along the lines of those described should have very few stoppages for repairs. However, to guard against such stoppages, the Deane works of the Worthington Pump & Machinery Corp. has used to advantage the crane inspection report shown in Fig. 37, which is filled out weekly.

To Require Reports

Ultimately, the state board of labor and industries of Massachusetts and other states, may require the foundries to fill out a similar report for all cranes and hoisting equipment. To further establish the safety of cranes, the code of safety standards for cranes of the American Society of Mechanical Engineers should be thoroughly studied and the practice there recommended, used. "Safe Practices", published by the National Safety Council, Vol. 1, No. 6, is a valuable treatise on the practical and safe application of the use of ropes, cables and chains.

Foundry sand, especially core sand and sand refuse, may frequently be handled conveniently by an automobile truck equipped with a dumping body similar to that illustrated in Fig. 29. A 5-ton truck of this type will cost, equipped, about $4500; will make 1 to 15 miles per hour and may be unloaded almost instantly and loaded i three to four minutes with a gas engine or motor-operated loading machine similar to that shown in Figs. 30 and 31, which costs from $900 t $1000.

Bucket Conveyors Expensive

Belt and bucket conveyors have been used to some extent in foundries especially two-story foundries an continuous pouring foundries. The expense, however, is usually too larg for them to be considered for th foundry doing the usual class of jobbing work, and therefore, I have no shown illustrations depicting the us of the belt or bucket conveyors.

The foregoing suggestions on th use and the operation of hoisting an conveying devices have proved o value and merit careful thought fo foundrymen endeavoring to stem th rising tide on operating costs.

Personal

W. Karl Hilbrich has been appointed purchasing agent of the Erie Malleable Iron Co., Erie, Pa.

G. W. Ketter, recently associated with the British Forgings Co., Ltd., Toronto, Ont., has joined the staff of the Electric Furnace Construction Co., Philadelphia.

Charles K. Logue has been appointed foundry superintendent of the Albany Car Wheel Co., Albany, N. Y. Mr. Logue was formerly associated with the Barney & Smith Co., Dayton, O.

Charles F. Hall, structural and mechanical engineer, has joined the staff of the Booth-Hall Co., Chicago, manufacturer of electric steel furnaces. Mr. Hall will be employed in the capacity of production manager.

F. D. Egan, for the past seven years steam and electrical engineer of the Midland plant of the Pittsburgh Crucible Steel Co., has become works manager of the Pittsburgh Iron & Steel Foundries Co., Midland, Pa.

David Lofts has been appointed senior chemical engineer of the American Steel Foundries, Chicago, to succeed J. S. Goddard, who died about a year ago. B. C. McFadden has been appointed assistant to Mr. Lofts.

Frank Wharton Brooke, formerly metallurgist with the John A. Crowley Co., Detroit, and the Ludlum Steel Co., Watervliet, N. Y., has joined the staff of the Electric Furnace Construction Co., Philadelphia.

E. R. Swanson has accepted the position of superintendent of the Duquesne Steel Foundry Co., Coraopolis, Pa., succeeding L. A. Way, resigned. Mr. Swanson was formerly assistant superintendent of the Commonwealth Steel Co., Granite City, Ill.

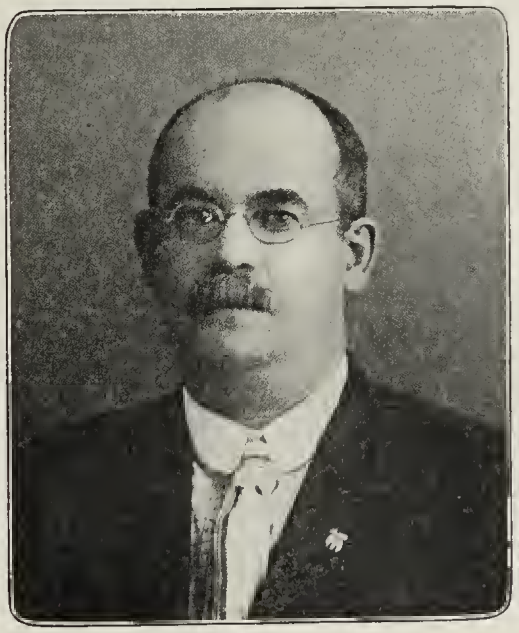
R. L. Browne recently has become associated with the sales department of the Goldschmidt Thermit Co., New York, in the capacity of commercial engineer. Mr. Browne spent several months in the foundry of this company, acquiring a practical knowledge of the thermit process of welding.

Stanton Griffith has accepted the position of works manager of the South Side Foundry & Machine Co., Charleston, W. Va. For the past 15 years Mr. Griffith has been superintendent of the foundry, pattern shop and chemical laboratory of the Fairbanks-Morse Mfg. Co., at Beloit, Wis.

Russell R. Clarke, formerly superintendent of the Brass Foundry operated by the Pennsylvania Lines West, Northside, Pittsburgh, and more recently affiliated with the Johnson Bronze Co., New Castle, Pa., in an executive capacity, has accepted the position of superintendent of the new plant of the Eagle Brass Foundry, Seattle.

Bert Cushman, who for a number of years has been foundry foreman of the Maxwell Motor Co.'s foundry at Dayton, O., has been appointed superintendent of the Fairview Foundry, Detroit, formerly owned and operated by the Chalmers Motor Co., which company is now a part of the Maxwell Motor Co., Inc. George Wise succeeded Mr. Cushman as foundry foreman of the Dayton plant.

Death of Frank H. Zimmers



FRANK H. ZIMMERS

Frank H. Zimmers, long prominent in Pittsburgh foundry circles, died at the Presbyterian hospital, Pittsburgh, Oct. 23, of pneumonia. He acted as secretary of the Pittsburgh Foundrymen's association since its organization, more than 20 years ago. Mr. Zimmers was born at Blairsville, Pa., 58 years ago. At the age of 16 he joined the engineers' corps of the Baltimore & Ohio railroad and after serving two years in this capacity, became associated with the Pennsylvania railroad, having charge as stationmaster of the Fourth avenue depot in Pittsburgh during the railroad riots in 1877. Returning to Blairsville, Mr. Zimmers engaged in the shoe business, which he conducted for eight years. Coming again to Pittsburgh, he became associated with the Union Foundry & Machine Co. and remained with that company until three years ago, when he resigned as its secretary. He then became affiliated with the National Steel Castings Co., New Cumberland, W. Va., as sales manager. He was also representative of the Weir & Craig Mfg. Co., Chicago. Later he organized the firm of Zimmers & Co., manufacturers and sellers agents for different lines of castings, machinery and equipment.

Additional sales of Greaves-Etchells electric furnaces have been announced by the Electric Furnace Construction Co., Philadelphia, as follows: A second six-ton furnace for the American Radiator Co., Buffalo; one 1-ton furnace for the Stoddard Union Co., Lockport, N. Y.; one special furnace for ferroalloys to the Primos Chemical Co., Primos, Pa., and one two-ton furnace to T. Waddell & Sons, New Zealand.

Malleable Foundry Nears Completion

A new malleable iron foundry to have an annual capacity of 6000 tons of castings yearly is being built by the Minneapolis Malleable Foundry Co., Minneapolis. A part of the plant has been completed and the installation of equipment commenced. The company plans to start operations in a limited way about Dec. 1, pending the completion of the entire plant. Contracts have been made covering a large part of its capacity. It is planned to specialize in light malleable castings; power squeezers have been installed and all melting and annealing will be done with fuel oil. The company is a Minnesota corporation organized with a capital stock of $100,000. F. C. Hughes is president and E. H. Williams is secretary and treasurer.

Changes in Shepard Organization

William A. Battey, who for many years has been connected with the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., as eastern sales manager and sales director, severed his active connection with the business on Dec. 1. He retains his interest in the company and will continue as a director. Mr. Battey, who is vice president of the Pennsylvania Crusher Co., finds it necessary to devote his entire attention to its rapidly expanding business in the manufacture of pulverizers, breakers and special crushing machinery for the by-product coke and other industries requiring reduction apparatus.

W. C. Briggs, who for the past 10 years has been associated with Mr. Battey in the Shepard company's New York office as sales engineer, has been appointed district manager. On Nov. 1, Robert T. Turner joined the New York organization as sales engineer.

The McLain-Carter Furnace Co., Goldsmith building, Milwaukee, will install another 5-ton open-hearth furnace in the plant of the American Machine & Mfg. Co., Atlanta, Ga.

Elmer P. Morris, 126 Liberty street, New York City, manufacturer of iron and brass castings, would like to receive copies of catalogs of foundry equipment, supplies and accessories, together with prices and discounts for export. The catalogs of Mr. Morris were destroyed recently by a fire in his office.

THE FOUNDRY

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Contents

PAGE
Agreed Prices and Their Meaning to Foundrymen............ 511
Furnace for Melting Copper—Zinc Alloys.................... 514
Organizing a Malleable Iron Foundry in 90 Days............ 515
Employment of Female Labor in the Foundry................. 519
How the Sales Engineer Views the Foundry.................. 520
A Troublesome Gating Problem.............................. 521
How to Solve a Foundry Lighting Problem................... 522
Labor Appreciates the Human Element....................... 524
Boilers Reclaim Melting Furnace Heat...................... 525
Preparing Sand for Steel Foundry Work..................... 526
Cincinnati Foundry for Making Special Castings............ 527
Melting Cast Iron in Crucibles............................ 530
Recently Developed Uses of Aluminum in Industry........... 531
Inspection of Brass and Bronze............................ 532
Aluminum Solders and Flux................................. 533
Bronze Substitute for Malleable Iron...................... 533
Shrinkage of Aluminum Matchplates......................... 533
Aluminum for Cooking Utensils............................. 534
Brazing Metal 534
Brass Alloys for Piston Rings............................. 534
Venting Cores for Brass Work.............................. 534
Cylinder Caps Which Crack................................. 534
Solving Foundry Transportation and Conveying Problems...... 535
Malleable Foundry Nears Completion........................ 545
Death of Frank H. Zimmers................................. 545
New Malleable Foundry is Soon to be Operated.............. 545
Personal 545
Changes in Shepard Organization........................... 545
Molding Machine—A War Implement........................... 546
Absorbs Elkhart Plant..................................... 547
Book Review 547
Clamp for Locking Flasks.................................. 547
Commercial Laboratory Established at Buffalo 547
Develops New Flask Clamp.................................. 547
Would Eliminate Flour in Cores............................ 547
How Slush Castings Are Made............................... 548
Coal Loader For Storage Piles............................. 548
Can't Splinter New Lens................................... 548
What the Foundries Are Doing.............................. 549
Index to The Foundry for 1916............................. 550

Molding Machine—A War Implement

MAINTAINING the casting plants of the country at their maximum operating capacity will be an increasingly difficult task, particularly when the second and third drafts further deplete the ranks of labor. The output of these shops must not be curtailed, yet their efficiency will be greatly impaired by the waning man-power and since all kinds of castings in large tonnages will be required for our army and navy for the duration of the war, something must be done at least to insure normal output. At the recent annual meeting of the National Founders' association it was stated that the available labor supply has declined fully 25 per cent and it was pointed out that there will be a further shrinkage as the war progresses. Furthermore, it was estimated that the jobbing shops of the United States are producing only at the rate of 50 per cent of their capacity and to raise their output to a basis commensurate with our present needs, it was stated that their practice must be improved, particularly by the installation of molding machines. Nor are the jobbing shops the only foundries whose methods of operation must be elevated to a wartime standard. Many engaged in other lines of work that may be characterized as semispecialties, also are remiss and a note of warning was sounded that there will be a shortage of castings unless mechanical appliances are adopted immediately to replace hand labor, so far as possible. The molding machine was given the place of honor among foundry mechanical devices that effect the greatest increase in output accompanied by a reduced labor expense, and their immediate widespread application and use not only was recommended, but urged. One of the most interesting and instructive features of this great gathering of foundrymen was a series of moving pictures that showed what is being done with molding machines in some of the large plants. On the various individual patterns, the increase in output, as compared with hand labor, was tremendous and the work illustrated proved the marvelous adaptability of these mechanical devices. It can safely be said that there is a molding machine for every class of work and the jobbing foundryman should have his shop as well equipped as any specialty plant. The employment of women for making cores is receiving more consideration and men engaged in such work, particularly if the cores are light, can be relieved by the employment of female labor. The greatest success, however, has been attained by the isolation of the departments in which the women are employed. Their working hours are different than those of the men engaged in the plant, so that they do not come in contact with them in going to or returning from work. Their surroundings should be congenial and they should be away from the smoke and grime of the shop.

Furnace for Melting Copper-Zinc Alloys

(*Continued from page* 514)

tion, or at least the current must be kept on to keep molten the metal in the secondary loop. It is not possible to change from one mixture to another, except that such change be possible as based on the composition of the metal remaining in the furnace. Experiments conducted by the company tend to prove that there is no great difference in resistance of the molten alloys ranging in composition from 95-5 to 60-40, so that it is possible to successfully melt alloys within this range in the furnace.

Electric Crucible Furnace

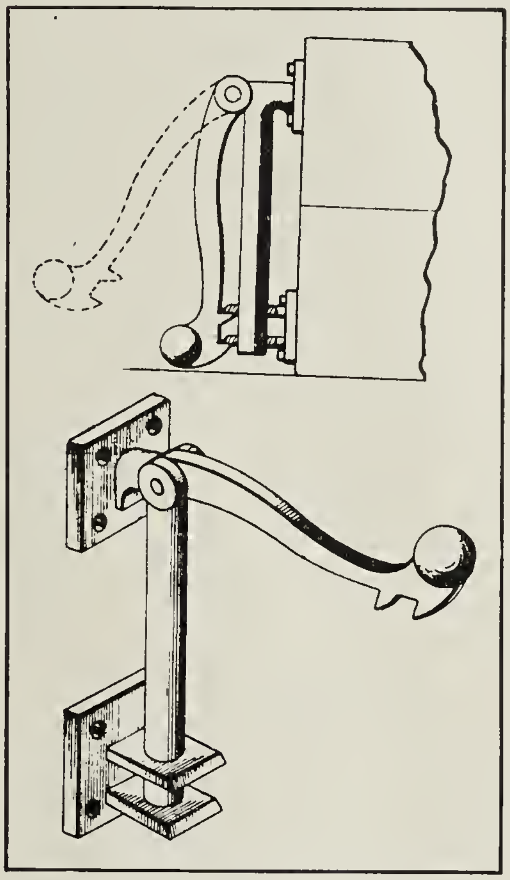
The company also is developing the Ajax-Northrup electric furnace. This furnace is of the induction type, but has no iron cores, as the induction is produced in conjunction with the crucible. It is possible to melt either conducting or nonconducting materials. The furnace operates on two-phase current with balanced loads on the two phases. Satisfactory results have been obtained by using plumbago crucibles as the heat is generated mostly in the metals and the crucible is at no time at a higher temperature than the metal contained in it. Since the crucible is not subjected to oxidizing influences, it is said to last long in service. This furnace may be used with or without crucibles, needs no liquid charge for starting, requires but a small amount of refractory material and is adapted for either intermittent or continuous operation. Tests have demonstrated that with a current consumption of 16 kilowatt hours, 45 pounds of brass scrap can be melted in 35 minutes. Temperatures of approximately 3000 degrees Fahr. have been attained.

Would Eliminate Flour in Cores

Foundrymen throughout the country are being urged by the United States food administration, headed by Herbert C. Hoover, to curtail or eliminate the use of flour for pasting cores, etc. It is pointed out that thousands of barrels of low-grade flour are used for this purpose every year in American foundries. Under normal conditions, this consumption is of no consequence to the food situation since the flour is not of a character ordinarily used in this country for food purposes. At present, however, this flour can be advantageously employed both here and abroad. At the same time it is pointed out that numerous prepared substitutes are available for foundry use some of which are much more efficient than flour. Foundrymen are urged to use these substitutes in place of flour. It is understood the food administration is seriously considering taking action which will prohibit the use of flour in any industry in this country.

Clamp for Locking Flasks

Castings are often spoiled because the flasks in which they are made become shifted due to loose pins or loose clamping. Run-outs, the results of inadequate clamping, or bumps or knocks administered to the mold, are likewise exceedingly troublesome. In order to eliminate these difficulties a pin and plate, cast in a single unit to prevent its working loose, were recently invented by John Sonnenfeld, superintendent, Lima Steel Castings Co., Lima, O. The lever attached to the pin is said to act as a clamp. The lever drops by gravity, as indicated in the accompanying illustration, to a vertical position and locks with the two feet cast in the plate.



CLAMP DESIGNED TO INSURE TIGHT LOCKING

Absorbs Elkhart Plant

The Davis-Bournonville Co., with general offices and factory at Jersey City, N. J., has taken over the plant and factory of the Davis Acetylene Co., Elkhart, Ind. The Davis Acetylene Co. has been dissolved and the manufacture of acetylene lighting generators and accessories discontinued. The plant hereafter will be operated under management from Jersey City for the manufacture of acetylene pressure generators for the oxy-acetylene process, and for special products. The Canadian factory at Niagara Falls, Ont., which had been jointly occupied by the two companies, has also been taken over, and will be operated exclusively for the manufacture of oxy-acetylene apparatus for the Canadian trade. The Davis-Bournonville Co. has also purchased the H. G. Kotten Co. factory and grounds opposite its Jersey City property. The Kotten factory will be used for manufacturing electrolytic oxygen apparatus and accessories, releasing considerable space in the company's new factory building for increased output of oxy-acetylene welding and cutting apparatus. A four-story warehouse, 60 x 100 feet, of brick and mill construction, will be immediately erected on the Kotten property, still leaving ground for a five-story factory, 60 x 150 feet, corresponding to the company's No. 3 factory, recently completed, which may be erected the coming year.

Book Review

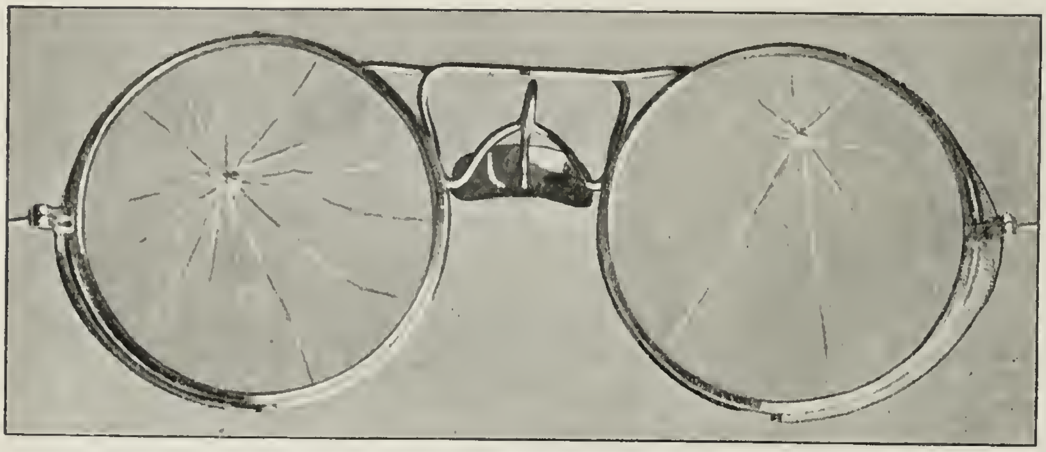
Hendricks Commercial Register for Buyers and Sellers, issued by S. E. Hendricks Co., Inc.; cloth; 2209 pages, 7½ x 9 inches; published by the S. E. Hendricks Co., Inc., and furnished by THE FOUNDRY for $10 net.

The twenty-sixth annual edition of Hendricks' Commercial Register of the United States has just been issued. The book has been revised, corrected and brought up to date. It is especially devoted to the interests of the architectural, contracting, electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, railroad, steel and kindred industries. Full lists are included of producers, manufacturers, dealers and consumers. All products, from the raw material to the finished article also are listed.

The text covers 2209 pages, the index to trade classifications alone extending over 151 pages, and includes over 50,000 trade references. The list of trade names, brands, titles of identification, etc., numbering 1212 pages, furnishes ready reference to distinctive products manufactured by concerns listed in the work. An alphabetical section, containing in one list the name, trade description and address of every concern appearing in the book, is published for the first time in this edition.

Commercial Laboratory Established at Buffalo

The Courtney-Fraser Co., Inc., Buffalo, has established a chemical laboratory at 529 Main street, which is modernly equipped throughout with apparatus for making analyses and tests of all kinds of foundry and steel works



WORKMAN'S GOGGLE EQUIPPED WITH NON-SPLINTERING LENSES

materials, castings, iron and steel products, etc. The offices of the company and the staff of assistants have had a wide experience, not only in laboratory work, but also in foundry practice.

Coal Loader for Ground Storage Piles

The problem of finding a convenient method of loading coal from ground storage, gave impetus to the invention of a wagon loader, which is now finding general application. The accompanying illustration shows a wagon loader manufactured by the Link-Belt Co., Chicago, loading coal into a motor truck at the plant of the American Optical Co., Southbridge, Mass.

The bituminous coal arrives in railroad cars and is dumped from the trestle to the ground storage pile. The power house is situated some distance from the storage pile which necessitates the use of a motor truck for rapid transportation. It is said that the wagon loader fills the truck in approximately five minutes. It is driven by an electric motor and requires one man for operation.

How Slush Castings Are Made

When a metal or carbon mold is filled with a low melting metal or alloy and the latter, after standing a brief interval is poured out of the mold again, a shell is left in the mold that takes the form of the latter and constitutes a hollow casting possessing a better proportioned wall thickness than it is possible to get with cores. Such castings usually take the form of more or less artistic articles, such as statuettes for clocks, lamp bases, etc. The metal is generally zinc and metal parts made in this way are known as *slush* castings. It has been found that the purer the zinc used, the better the castings and the less trouble experienced from cracking. It is common practice to add a small amount of aluminum to the zinc for making slush castings as it clears the surface of the metal and makes it run better. About 0.10 per cent or even less of aluminum is used, but it is a curious fact that while 2 or 3 per cent of aluminum will cause the zinc to become stiff and slushy, with 5 per cent aluminum the zinc pours well and produces good castings. Since aluminum increases the cost of the zinc, it is most generally used as a deoxidizer for making slush castings, and not for producing an alloy, and the amount added is less than 0.10 per cent. Some manufacturers have found that the addition of not to exceed 0.005 per cent of aluminum increases the fluidity of the zinc and permits slush castings to be made that are free from cold shuts and cracks. This small amount of aluminum is most conveniently added in the form of a mixing alloy of zinc and aluminum.

Can't Splinter New Lens

A new goggle with lenses that are said not to scatter particles even though badly broken, has been developed by the Strong, Kennard & Nutt Co., Cleveland. By a patented process two pieces of optical glass, with a sheet of transparent celluloid between them, are fused together without cement. The lens, it is said, has 97.64 per cent transparency.

It is claimed that this lens has unusual strength in that it is not easily penetrated, and even when penetrated the particles hold together, thus removing one drawback to the wearing of goggles. The two pieces of glass and the piece of celluloid composing each lens are fused together after the glass is cut to size and shape, as it is impossible to work the process in the reverse order. The peculiarity of the manufacture prevents sweating.

The Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., manufacturer of conveying and elevating machinery, has established an export department at 30 Church street, New York.

The Pangborn Corp., Hagerstown, Md., has purchased the sand blast department of the Curtis Pneumatic Machinery Co., St. Louis. A complete line of machines will be carried in stock including repair parts.

The Whiting Foundry Equipment Co., Harvey, Ill., now is directly represented in Pittsburgh and vicinity by F. J. Page, located at 411 Fulton building. Mr. Page has been in the employ of the Whiting Foundry Equipment Co. for many years in both the estimating and sales departments.

H. Kramer & Co., Chicago, metal refiners, smelters and dealers, now are located in their new foundry and warehouse built on a 1-acre site at 1324 to 1344 West Twenty-first Place. Shipping facilities are provided by a side tract connecting directly with Chicago, Burlington & Quincy railroad. This company purchases type dross and brass skimmings and ashes.

MACHINE LOADING COAL ON 3½-TON TRUCK FROM GROUND STORAGE PILE

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Skinner & Eddy Corp., Seattle, will build a foundry, 60 x 150 feet.

The Novo Engine Co., Lansing, Mich., will build a foundry and machine shop.

The Westinghouse Electric & Mfg. Co., East Pittsburgh, will build a $50,000 foundry.

Wickes Bros., Saginaw, Mich., contemplates the addition of a foundry to their plant.

A contract has been let for the erection of a 70 x 85-foot addition to the plant of the Fairmount Foundry Co., Woonsocket, R. I.

The Liberty Foundries Co., Rockford, Ill., has increased its capital stock from $5000 to $25,000.

The Boston Stove Foundry Co., Boston, has been incorporated by Louis Cohen, Joseph Lanes and Isaac Bachrach with $50,000 capital.

The United States Malleable Iron Co., Toledo, O., has increased its capital stock from $250,000 to $350,000.

Walloch Foote and Oscar Berg have organized the Advance Brass Mfg. Co., Muskegon, Mich., and will make brass castings.

The Ben Sibbett Iron & Foundry Co., Wichita, Kans., has been incorporated with a capital stock of $30,000.

A contract has been awarded by the Interstate Foundry Co., Cleveland, for the erection of a $20,000 addition.

The, Cooley Mfg. Co., Seattle, Wash., contemplates building a brass foundry and other additions to its plant.

The Barton Tannery Co., 310 Hunter street, Newark, N. J., will build a steel foundry, 39 x 100 feet, at a cost of $20,000.

The Otto Biefeld Co., Watertown, Wis., will build a foundry and machine shop addition at a cost of approximately $35,000.

The Moreland Motor Truck Co., 1701 North Main street, Los Angeles, is erecting an electric steel foundry, 60 x 120 feet.

S. A. Michler, San Francisco, will erect a two-story foundry and machine shop at a cost of $10,000.

The Sydney Foundry & Machine Co., Sydney, N. S., will build a foundry at Halifax, N. S., at a cost of $7500.

A contract has been awarded by the Essex Foundry Co., Newark, N. J., for the erection of an addition.

The A. W. Wheaton Brass Works, Newark, N. J., will build a brick, 33 x 50-foot brass foundry at a cost of $4000.

The General Electric Co., Everett, Mass., has let the contract for a 42 x 210-foot addition to its foundry.

The Barlow Foundry Co., Newark, N. J., will erect a foundry of brick and steel construction. The estimated cost is $20,000.

The American Radiator Co., Buffalo, will build a 120 x 200-foot foundry at a cost of $150,000.

A contract has been awarded for the erection of a new plant for the Van Wert Foundry Co., Van Wert, O.

The Atlas Steel Casting Co., 1963 Elmwood avenue, Buffalo, will erect an addition, 40 x 96 feet, at a cost of $4000.

The Waterloo Gasoline Engine Co., Waterloo, Ia., will build a 120 x 525-foot foundry, of brick and concrete construction.

The Grabler Mfg. Co., 6565 Broadway, Cleveland, has awarded the general contract for a 3-story, 47 x 130-foot foundry.

Plans are being prepared for a steel foundry to be erected for the Fulton Steel Corp., Fulton, N. Y., at a cost of $60,000.

The Culinary Mfg. Co., 35 Day street, Orange, N. J., contemplates adding a foundry to its plant.

The Ohio Steel Foundry Co., Lima, O., contemplates the erection of several additions to its plant.

The Zanesville Malleable Co., Zanesville, O., has purchased a three-acre site on which it will build a plant, 50 x 150 feet.

The Master Carburetor Co., Los Angeles, has been incorporated with $200,000 capital, by D. F. Poyer, E. M. Chandler and Charles G. Harness.

The Stewart Mfg. Co., 323 Wells street, Chicago, manufacturer of die castings, has changed its name to the J. K. Stewart Specialty Co.

W. G. Schell has bought the plant of the Uplands Foundry & Machine Co., Uplands, Cal., which he will equip for the manufacture of heaters and distillate burners.

The Lycoming Foundry & Machine Co., Williamsport, Pa., has purchased the plant of the United States Machine Co. in that city, and has remodeled it into a foundry.

James and Waldo Kuffman have organized the Ashland Brass Foundry Co., Ashland, O., and are building a plant for the manufacture of brass and aluminum castings.

Contracts have been awarded by the Meadville Malleable Iron Co., Meadville, Pa., for the erection of a three-story, 35 x 120-foot foundry of reinforced concrete construction.

The St. Louis Malleable Casting Co., St. Louis, will build a steel foundry, a small forging plant and a brass shop on a 3½-acre site which it recently purchased.

R. H. Hassler, Indianapolis, manufacturer of automobile appliances, will build a foundry at 1531 Naomi street. The estimated cost is $17,000.

Bids are being received for a tire mold building to be erected for the Wilson Foundry & Machine Co., Pontiac, Mich. The expenditure will approximate $30,000.

Plans are being prepared for the erection of a large addition to the foundry and machine shop of the Arneson Foundry Co., Kenosha, Wis.

The Chicago Stove & Range Co., 2033 South Clark street, Chicago, will erect a $20,000 foundry at its plant at Benton Harbor, Mich.

The Pusey & Jones Co., Wilmington, Del., will build a $70,000-foundry, a $50,000-pattern storage room and a $10,000-pattern shop addition, making a total expenditure of $130,000.

The Newport News Shipbuilding & Drydock Co., Newport News, Va., contemplates the erection of additions to its foundry, machine shop and other buildings.

Plans have been completed for a 60 x 80-foot foundry to be erected for George Mockley, 3901 Ninth avenue south, Seattle, at a cost of $3000.

The Gunning Boiler & Machine Co., New Bedford, Mass., will build a four-story, 36 x 134-foot addition to its foundry and machine shop.

The J. C. Born Machine & Foundry Co., Belleville, Ill., has been incorporated with $10,000 capital, by John C. Born, William F. Born and E. W. Twenhoefel.

The Southern Equipment Co., Memphis, Tenn., has been incorporated with $25,000 capital to engage in the foundry business. The incorporators are R. H. McWilliams, N. M. Dickson, A. W. Fisher Jr. and D. B. Sweeney.

The Oxford Foundry & Machine Co., Oxford, N. J., has been incorporated to engage in the manufacture of machinery with $50,000 capital. The incorporators are William A. Bartley, Howard L. Coas and Bernard Brady.

The John Davenport Co., Stamford, Conn., has sold its foundry to A. B. Venesch & Co., bankers, New York, who will conduct the business. Improvements costing $500,000 will be made.

The industrial committee of the Veedersburg commercial club will build a stove plant which will include a foundry, one story, 50 x 91 feet; a cleaning room, 30 x 31 feet; a machine shop and an office.

The Thompson Heater Corp., Buffalo, contemplates the erection of a new gray iron foundry with a daily capacity of 10 to 15 tons. The equipment has not yet been purchased.

The Astoria Marine Iron Works, Astoria, Oreg., is considering a site on which it proposes to build a large machine shop and a foundry for the manufacture of marine equipment.

The Mueller Mfg. Co., Decatur, Ill., will build a branch plant at Port Huron, Mich., which will include a brass foundry, 86 x 140 feet; a rod mill, 80 x 100 feet, and a power house. The cost will approximate $400,000.

The Ecorse Foundry & Machine Co., Ecorse, Mich., which recently completed a foundry for the manufacture of motor car and tractor wheel castings, is building additions which will increase its capacity from 60 to about 100 tons per day.

The R. W. G. Foundry Co., Anderson, Ind., recently has placed a foundry in operation for the manufacture of gray iron castings. The officers of this company follow: J. E. Westerfield, president; M. G. Reynolds, vice president and J. C. Groble, secretary and treasurer.

A contract has been let by the Blake & Knowles Works of the Worthington Pump & Machinery Corp., Cambridge, Mass., for the erection of a foundry addition, one-story, 80 x 120 feet, and a brick and concrete building, four stories, 65 x 120 feet.

Albert W. Wagner, Thomas W. Samuels and Charles C. Leforgee have organized the Wagner Castings Co., Decatur, Ill., with $40,000 capital, and have taken over the business of the Decatur Foundry Co. The new company will continue the manufacture of light gray iron castings and later also will make malleable castings.

Index to Volume XLV

January---December, 1917

A

Abell-Howe Co. 398
Abrasive Wheel Manufacturers, Grinding Wheel Standards........
....Data Sheets Nos. 227 and 228, Feb.
Accidents, Grinding Wheel, Table of Causes of........
....Data Sheets Nos. 225 and 226, Jan.
Accidents, Preventing, in Industrial Yards 461
Acid, Acetic, Bronze Mixture to Resist. . 236
Acid and Basic Electric Steel, Castings from 220, 269
Advantages of Hand and Power Machine Molding 285
Aeroplane Metal 30
Aeroplane Motor Castings, Mixture for... 116
Air Compressor for Foundry Use........ 168
Ajax Metal....Data Sheet No. 246, Nov.
Ajax Metal Co., Furnace for Melting Copper-Zinc Alloys 514
Ajax Plastic Bronze........
.........Data Sheet No. 245, November
All Iron is Good Iron........ 14
Alloy, 80-10-10, Properties of the.....272, 311
Alloy, 88-10-2 271
Alloy, Electric Resistance........ 301
Alloy Information, Bureau of Standards Asks 205
Alloy, Non-Shrinkable Pattern........ 447
Alloy, White Aluminum........ 196
Alloy, White Brass........ 72
Alloy, White Metal Pattern........ 285
Alloy, White Nickel, Very Stiff........
..............Data Sheet No. 237, July
Alloy, Zinc, for Match-Plates........ 31
Alloys, Aluminum ....
...Data Sheets Nos. 235 and 236, June
Alloys, Aluminum ....
....Data Sheets Nos. 241 and 242, Sept.
Alloys, Aluminum, Nomenclature of...... 285
Alloys and Metals, Sand-Cast, Results of Tests of 270
Alloys, Copper Zinc, Hardness of....... 155
Alloys, Gas as Fuel for Melting........ 193
Alloys, Names and Composition of Miscellaneous ....
...Data Sheets Nos. 247 and 248, December
Alloys, Proprietary Bearing........
....Data Sheets Nos. 245 and 246, Nov.
Alloys Similar to Duraluminum, Mixtures of 284
Alloys, Strong Aluminum........ 327
Alumina, Study of Inclusions of, in Steel 197
Aluminum Alloys ....
....Data Sheets Nos. 235 and 236, June
Aluminum Aloys ....
Data Sheets Nos. 241 and 242, Sept.
Aluminum Alloys, Nomenclature of....... 285
Aluminum Alloys, Strong........ 327
Aluminum-Bronze Castings 157
Aluminum-Bronze Castings, Soldering.... 284
Aluminum Bronze, Soldering........
.........Data Sheet No. 244, October
Aluminum Bronze, Ten Per cent........ 273
Aluminum-Bronze Tests and Their Significance 21
Aluminum Bronze, Titanium and........ 505
Aluminum Casting Difficulties........ 496
Aluminum Castings, Making Large Pure. . 98
Aluminum, Copper-Plating 283
Aluminum for Cooking Utensils........ 534
Aluminum Match Plates, Making........ 79
Aluminum Match Plates, Shrinkage of.... 533
Aluminum Mixture for Pistons........ 497
Aluminum, 92 Per Cent and Copper, 8 Per Cent 273
Aluminum Nitride 497
Aluminum, No. 31, Mixture of........ 72
Aluminum, No. 12........ 115
Aluminum Pistons, Mixture for........ 31
Aluminum, Recently Developed Uses of, in Industry 531
Aluminum, Removing, from Brass........ 448
Aluminum Solders and Flux........ 533
Aluminum, White, Alloy........ 196
American Foundry Equipment Co., Develops Large Sand-Blast Barrel........ 124
American Foundry Equipment Co., Sand-Blast Machines 263
American Foundry Equipment Co., New Departure in the Design of Sand Blast Apparatus 168
American Foundry in a Time of War..... 127
American Foundrymen's Association, Boston Prepares for Founders' Week 245
American Foundrymen's Association, Foundrymen Display Keen Interest in Boston Show 290
American Foundrymen's Association, Installing a Uniform Cost System in Foundries 206
American Foundrymen's Association, Ladle Sleeves and Stoppers........ 451
American Foundrymen's Association, Program of 343
American Foundrymen's Association, Spirit of Service Pervades Meeting of........ 411
American Institute of Metals, Boston Prepares for Founders' Week........ 245
American Institute of Metals Prepares a Great Program 311
American Institute of Metals, Program of 343
American Institute of Metals Puts in a Busy Week 424
American Molding Machine Co., New Type of Roll-Over Molding Machine........ 507
American Museum of Safety, Safety Awards Announced 153
American Radiator Co., Removing Traditional Evils of Malleable Practice.....73, 398
American Society for Testing Materials, Annual Meeting of........ 98
American Society for Testing Materials Considers New Specifications........ 270
American Society for Testing Materials Outlines Comprehensive Program....... 243
American Society for Testing Materials, Tentative Specifications for Brass Castings 446
American Steel Foundries, Self-Skimming Ladle for Pouring Steel for Castings.... 244
Analyses for Anti-Friction Metal........ 284
Analyses of Bearing Metals........ 236
Analysis of Benedict Metal........ 72
Anodes, Nickel, Trouble with........ 71
Anodes, Scrap Nickel, Reclaimed by Welding 484
Anti-Acid Bronze 115, 497
Anti-Friction Metal 157
Anti-Friction Metal, Analyses for........ 284
Arch, Roof, for Annealing Ovens........ 509
Army, Uncle Sam's New, Making Cook Stoves for 389
Art Work, Gray Iron, Making........ 85
Art Work, White Metal for........ 196
Artistic Gray Iron Castings Made by Russian Foundrymen 359
Ashes, Brick Made from........ 248
Automobile Motor Castings are Molded, How 469
Automobile, The Foundry Behind the..... 223
Average Output of Cupolas........
..............Data Sheet No. 234, May
Avoiding the Cutting of Cores........ 447

B

Babbitt Metal, How to Melt........ 369
Babbitt Metal, Scrap, Utilizing........ 236
Babbitting Thrust Collars, Method of.... 284
Balls, Cast Iron, for Grinding Mills...... 14
Balls, Chilled Cast Iron, How to Make. . 288
Balls, Chilled Iron........ 321
Barlow Foundry Reorganized........ 153
Barnes Foundry & Mfg. Co. To Make Automobile Castings 452
Basic and Acid Electric Steel, Castings from 220, 269
Bauxite, Production of, in 1916........ 305
Bearing Alloys, Proprietary........
....Data Sheets Nos. 245 and 246, Nov.
Bearing Metals, Analyses of........ 236
Bearings, Cheap Car Journal, Mixture for 70
Bearings, Journal, Casting........ 111
Bearings, Rolling Mill........ 116
Belt Slings for Cores........ 102
Bench, Patternmaker's Work, Top for the 246
Benedict Metal, Analysis of........ 72
Benedict Nickel ....
..............Data Sheet No. 238, July
Beryllium 194
Bethlehem Steel Co. Makes Large Iron Mold for Guns........ 188
Bins, Storage, Durable, Design for....... 502
Blackwood Steel Foundry Co., New Converter Plant for Economical Operation 133
Blocks, Wire Drawing........ 71
Board, Patternmakers' Construction...... 369
Boilers Reclaim Melting Furnace Heat... 525
BOOK REVIEWS:
  Annual Chemical Directory of the United States 251
  Selling Your Services........ 93
  The Founder's Manual........ 260
  The Principles of Iron Founding....... 489
Booth-Hall Co., Employs Auxiliary Electrode 466
Booth-Hall Co. Will Build Electric Furnaces 273
Boring Mill, Casting Floor Plate and Bed for a........ 491
Boston Prepares for Founders' Week..... 245
Boston Welcomes the Great Army of foundrymen 343
Brass Alloys for Piston Rings........ 534
Brass and Bronze Castings, Inspection of 154
Brass and Bronze, Inspection of........ 532
Brass, Brazing, Difficulties in Making.... 30
Brass Castings, Shrinkage Difficulties in. 71
Brass Castings, Cleaning Solution for..... 30
Brass Castings, Cleaning, with Acid....... 448
Brass Castings, Color of........ 157
Brass Castings, Facings for........ 196
Brass Castings, How to Prevent Pin Holes in 327
Brass Castings, Making Thin Wall Ornamental 13
Brass Castings, Minute Cavities in....... 448
Brass Castings, Porous........ 29
Brass Castings, Tentative Specifications for 446
Brass Castings, Trying to Use Poor Scrap in 30
Brass Cleaner and Deoxidizer........ 114
Brass Concentrates, Metal from........ 497
Brass, Core Sand for........ 326
Brass, Failure of........ 114
Brass Foundry, Plaster of Paris in the... 326
Brass Foundry, What the, Has Done in 25 years 386
Brass Foundrymen, Formulas for the... Data Sheets Nos. 235 and 236, June; 237 and 238, July; 241 and 242, September; 243 and 244, October; 245 and 246, November; 247 and 248, December.
Brass, Melting, in a Gas-Fired Cupola Furnace 189
Brass, Melting, in the Cupola........ 496
Brass Particles, Flux for........ 196
Brass Particles, Small, Flux for........ 157
Brass Plungers, Pitted........ 31
Brass, Progress in Casting, in Permanent Molds 70
Brass, Red, Mixtures, Cheap........ 285
Brass, Refining the Grain of........ 156
Brass, Removing Aluminum from........ 448
Brass Scrap, Thin, Rolled, Utilizing..... 236
Brass, Suggestions for Melting........ 495
Brass, White, Alloy........ 72
Brass, White, for Automobile Door Handles 236
Brass, Yellow, Castings, Rough and Dirty 448
Brass, Yellow, Mixing and Melting....... 116
Brazing Brass, Difficulties in Making..... 30
Brick Made from Ashes........ 248
Brick, Refractory, Slag Test for, in Steel Industry 340
Bridging, Cupola, Preventing........ 310
Bridging, Slow Melting and........ 97
Briquettes Fuel Oil, How are Used..... 289
Bright, Smooth Surface on Castings...... 79
British Foundrymen's Association Annual Report 306
British Foundrymen's Association, Abstracts from Papers Read at........ 302
British Foundrymen's Association, Increased Use of Molding Machines in English Foundries 37
British Foundrymen's Association Plans Program for 1917-1198........ 509
British Institute of Metals Meets........ 132
British Institute of Metals, Summary of Papers Presented at........ 189
Bronze, Ajax Plastic........
.........Data Sheet No. 245 November
Bronze, Aluminum, Castings........ 157
Bronze, Aluminum, Castings, Soldering... 284
Bronze, Aluminum, Soldering........
..........Data Sheet No. 244, October
Bronze, Aluminum, Ten Per cent........ 273
Bronze, Aluminum, Tests and Their Significance 21
Bronze and Brass Castings, Inspection of 154
Bronze and Brass Sticks, Porous........ 31
Bronze, Anti-Acid 115, 497
Bronze Bushings, Difficulties in Casting... 236
Bronze, Carbon, Cornish and Damascus. .
........Data Sheet No. 246, November
Bronze Casting Molding Job, Difficult.... 234
Bronze, Manganese, How to Mix and Melt 72
Bronze, Manganese, Introducing Iron Into 71
Bronze, Manganese, Properties of........ 272
Bronze, Manganese Unusually Strong.... 31
Bronze Mixture, Difficult, to Cast........ 115
Bronze Mixture to Resist Acetic Acid.... 236
Bronze Parts, Mixture for........ 13
Bronze, Statuary, Open-Flame Furnace for Melting 246
Bronze, Titanium and Aluminum........ 505
Bronze to Resist Mine Water........ 497
Bronze, Tobin 115
Bronze, Tobin, Mixture........ 157
Bronze, Vanadium, Making........ 497
Bronze, Vanadium, Submarine Castings... 121
Bronze, Wax-Finishing 156
Bronzes, Properties of, for Mechanical Purposes 68
Buick Motor Co., The Foundry Behind the Automobile 223
Bureau of Standards Asks Alloy Information 205

Bureau of Standards Recommends Standard Screen Scale for Sieves.... 163
Bushings and Gear Blanks, Remedying Brittle 327
Bushings, Bronze, Difficulties in Casting.. 236

C

Calcium and Its Uses.... 260
Calculating Tensile from Transverse Strength 445
Can Government Metal be Forged?.... 448
Canadian Pacific Railway Co., Casting Chilled Car Wheels in a Canadian Foundry 297
Car Wheels, Chilled, Casting in a Canadian Foundry 297
Car Wheels, Mine, Chilling.... 315
Carbon Bronze..Data Sheet No. 246, Nov.
Carbon, Combined, To Reduce.... 47
Care to be Exercised in Vibrator Operation 249
Carmelia Metal..Data Sheet No. 246, Nov.
Cast Iron Balls, Chilled, How to Make... 288
Cast Iron Balls for Grinding Mills.... 14
Cast Iron, Losses in Melting.... 222
Cast Iron, Malleable, Shrinkage of.... 19
Cast Iron Molds and Cores, Use of.... 164
Cast Iron Shells, Making, in Permanent Molds 439
Cast Iron Work, Control of Cooling Metal in 302
Cast Metal, Influence of Occluded Gases in 149
Casting Brass in Permanent Molds, Progress in 70
Casting, Bronze, Molding Job, Difficult... 234
Casting Chilled Car Wheels in a Canadian Foundry 297
Casting Difficulties, Aluminum.... 496
Casting Difficulty, Brass, Due to Insufficient Feeding 30
Casting Floor Plate and Bed for a Boring Mill 491
Casting, Gear Cover, Quick Method of Making a 146
Casting Iron Around a Rigid Center.... 20
Casting, Large, Repairing a, by Electric Arc Welding 120
Casting, Large, Varying Strength in Different Parts of a 305
Casting Malleable Iron in Permanent Molds 40 40
Casting Nonferrous Metals, Chill Molds for 28
Casting Plant, Steel, Electric Furnace in the 232
Castingr Poduction in 1916.... 164
Casting, Propeller, is Essential to Our Defense 366
Casting, Steel, Specifications, Navy Revises 318
Casting Steel Wheels for Motor Trucks... 61
Castings, Aeroplane Motor, Mixture for... 116
Castings, Aluminum-Bronze 157
Castings, Aluinum-Bronze, Soldering.... 284
Castings, Artistic Gray Iron, Made by Russian Foundrymen 359
Castings, Automobile Motor, Are Molded, How 469
Castings, Brass, Cleaning Solution for.... 30
Castings, Brass, Cleaning, with Acid.... 448
Castings, Brass, Color of.... 157
Castings, Brass Facings for.... 196
Castings, Brass, How to Prevent Pin Holes in 327
Castings, Brass, Making Thin Wall Ornamental 13
Castings, Brass, Minute Cavities in.... 448
Castings, Brass, Porous.... 29
Castings, Brass, Tentative Specifications for 446
Castings, Brass, Trying to Use Poor Scrap in 30
Castings, Bright, Smooth Surface on.... 79
Castings, Bronze and Brass, Inspection of 154
Castings, Chilled, from a Cupola Running Gray Iron 188
Castings, Copper, Deoxidizer for.... 72
Castings, Copper, Porous.... 195
Castings, Early Artisans' Masterpiece, Remarkable Gray Iron Reproductions of .... Supplement, October
Castings, Early Use of Permanent Molds for 274
Castings for Pianos, Making.... 285
Castings from Acid and Basic Electric Steel 220, 269
Castings, Gray Iron, Effects of Seasoning on 435
Castings, Gray Iron, Unique.... ....Supplement, November
Castings, How to Eliminate Sulphur Holes in 119
Castings, Large Pure Aluminum, Making. 98
Castings, Magnalium 196
Castings, Malleable Iron, Producing Machinable 449
Castings, Malleable, Modern Method of Gating 319
Castings, Manganese Steel, Manufacture of 141
Castings, Motor Car, How Cores for, Are Made 255
Castings. Nonferrous, Making, in a Railroad Shop 1
Castings, Oxy-acetylene Torch, Mixture for 327
Castings, Railroad Malleable, Tentative Specifications for 295
Castings, Rough and Dirty Yellow Brass 448
Castings, Seasoning of 96
Castings, Semisteel 248
Castings, Semisteel, Properties of.... 53
Castings, Sound, Use of Chills in Producing 302
Castings, Steel, Cores for.... 246
Castings, Steel, Effect of Copper on Shrinkage of 165
Castings, Steel, for Ordnance Construction 453, 477
Castings, Steel, Heading, Gating and Chilling 304
Castings, Steel, How to Use Titanium in Making 15
Castings, Steel, Output of.... 254
Castings, Steel, Progress in the Manufacture of 328
Castings, Steel, Repairing Cracks in, Electrically 306
Castings, Stove, Mixture for.... 452
Castings, Strong 165
Castings Subjected to Hydrostatic Test... 283
Castings Subjected to Water Pressure.... 327
Castings, Vanadium Bronze Submarine... 121
Castings with a White Core.... 130
Cause of Flaking.... 447
Chains, Strength of.... ....Data Sheet No. 239, August
Charging, Cupola 93
Cheap Mixture for Locks.... 157
Cheap Red Brass Mixtures.... 285
Chemical Elements, Melting Points of the ....Data Sheet No. 233, May
Chicago Foundrymen's Club Elects Officers 82
Chill Cracks in Lathe Beds.... 182
Chill Molds for Casting Nonferrous metals 28
Chilled Castings from a Cupola Running Gray Iron 188
Chilled Iron Balls.... 321
Chilling Mine Car Wheels.... 315
Chilling Steel Castings, Heading, Gating and 304
Chills, Use of, in Malleable Iron Practice 303
Chills, Use of, in Producing Sound Castings 302
Cleaning Brass Castings with Acid.... 448
Cleaning Solution for Brass Castings.... 30
Cleveland Co-Operative Stove Co., New Cleveland Stove Foundry for Maximum Output 307
Cleveland Salt Works, Demonstrating the Reliability of Motor Drive.... 40
Coal, Bituminous, Melting in a Cupola with 67
Coal, Powdered, as a Fuel in Malleable Shops—IV 32
Coal, Pulverized, for Melting Malleable Iron 487
Coal Screenings, Melting with.... 156
Coatings, Protective: Japans and Enamels —II 138
Coatings, Protective: Lacquers—I 103
Coke Bed, Determining Proper Weight of 132
Collars, Thrust, Method of Babbitting.... 284
Color of Brass Castings.... 157
Colorado Fuel & Iron Co., Large Scrap Melting Cupola 462
Concentrates, Brass, Metal from.... 497
Connections, Sizes of, for Wood-Working Machinery......Data Sheet No. 230, March
Conserve Our Metal Resources, How We May 209
Constructing a Simple Pattern.... 13
Construction Board, Patternmaker's.... 369
Contraction, Shrinkage and.... 5
Control of Cooling Metal in Cast Iron Work 302
Converter Plant, New, for Economical Operation 133
Conveying and Transportation Problems, Foundry, Solving 535
Conveyors, Gravity, for Foundry Materials 508
Cooper, H. W., Saddlery Hardware Mfg. Co., Hand Squeezers.... 507
Copper Castings, Deoxidizer for.... 72
Copper Castings, Porous 195
Copper, Effect of, on Shrinkage of Steel Castings 165
Copper, Experiments with Sulphur in.... 447
Copper, Melting, in Cupola.... 195
Copper-Melting Medium, Electric Furnace as a 280
Copper, Phosphor, and Phosphor-Tin, Effects of 71
Copper-Plating Aluminum 283
Copper, Selenium in.... 369
Copper Turnings, Utilizing.... 283
Copper, Welding 115
Copper Zinc Alloys, Hardness of.... 155
Core Buster, New.... 249
Core Compound Manufacturers Beware!.. 294
Core Oven, Improved.... 408
Core Reducer 293
Core Sand for Brass.... 326
Core Sand Mixture for Globe Valves.... 447
Core, White, Castings with a.... 130
Cores, Avoiding the Cutting of.... 447
Cores, Belt Slings for.... 102
Cores, Cast Iron Molds and, Use of.... 164
Cores for Motor Car Castings, How, Are Made 255
Cores for Steel Castings.... 246
Cores, Radiator, Economical.... 462
Cores, Venting, for Brass Work.... 534
Coring and Molding a 5-Ton Gear Cutter Bed 363
Cornish Bronze ....Data Sheet No. 246, November
Cost Accounting, Foundry, Essential Factors in 90
Cost of Patterns, Influence of Design on the 33, 301
Cost of the Cupola Heat, Figuring the.. 102
Cost System for a Small Malleable Foundry 9
Cost System in Foundries, Uniform, Installing a 206
Costs, Ingot Mold, How Walker Process Reduces 158
Counting Machine, Screw.... 124
Cracks, Chill, in Lathe Beds.... 182
Craftwork in the Foundry.... .... Supplement, October
Crucible, Test of.... 206
Crucibles, Electric Heating of.... 194
Crucibles, How the War Affects Manufacture of 494
Crucibles, Melting Cast Iron in.... 530
Crucibles, Safe Handling of, in the Foundry 316
Crude-Oil Furnace, Melting in a.... 194
Cubic Feet of Air Handled Through Average Dust-Collecting Hoods.... ....Data Sheet No. 229, March
Cupola Bridging, Preventing.... 310
Cupola Charging 93
Cupola Doors, Counter-Balanced 465
Cupola Flux, Limestone for.... 118
Cupola Fuel, Oil Residue as a.... 205
Cupola Furnace, Gas-Fired, Melting Brass in 189
Cupola Heat, Figuring the Cost of the... 102
Cupola, Large Scrap Melting.... 462
Cupola, Melting Brass in the.... 496
Cupola, Melting Copper in.... 195
Cupola, Melting in a, with Bituminous Coal 67
Cupola Running Gray Iron, Chilled Castings from a.... 188
Cupola, Small, to Increase the Melting Capacity of a.... 291
Cupolas, Average Output of.... ....Data Sheet No. 234, May
Cylinder Caps Which Crack.... 534
Cylinders, Mixture for.... 202

D

Damascus Bronze ....Data Sheet No. 246, November
Davis, James C., Self-Skimming Ladle for Pouring Steel for Castings.... 244
Davis-Bournonville Co., Welding Institute Established 387
Demonstrating the Reliability of Motor Drive 40
Deoxidizer, Brass Cleaner and.... 114
Deoxidizer for Copper Castings.... 72
Deoxidizing and Refining Process, Schwartz. 294
Design for Durable Storage Bins.... 502
Design, Influence of, on the Cost of Patterns 33, 301
Design, Pattern, from the Foundrymen's Viewpoint 37
Designing a Modern Foundry of Moderate Size 43
Determining Proper Weight of the Coke Bed 132
Detrick, M. H., Co., Roof Arch for Annealing Oven 509
Die-Casting Process, Evolution of the.237, 265
Different Kinds of Iron.... 82
Difficult Bronze Casting Molding Job.... 234
Difficult Mixture to Cast.... 115
Difficulties Arising from the use of Lead.. 284
Difficulties in Casting Bronze Bushings.. 236
Difficulties in Making Brazing Brass.... 30
Difficulties, Shrinkage.... 116
Difficulties Due to Insufficient Feeding.... 30
Do Grinding Wheels Actually Grind?.... 203
Does Copper Affect Shrinkage of Steel Castings? 165
Duraluminum, Mixtures of Alloys Similar to 284
Dust-Collecting Hoods, Cubic Feet of Air Handled through Average.... .... Data Sheet No. 229. March

E

Early Stove Manufacture in the United States 247
Early Use of Permanent Molds for Castings. 274
Early Types of American Heating Stoves.. 336
Economical Radiator Cores.... 462
EDITORIALS:
  A Call to Duty.... 166
  A Problem for Foundrymen.... 204
  Are Conventions Worth While in War Time? 250
  Are You Doing Your Share?.... 122

  Capitalize Your Convention Trip...... 464
  Co-Operation Thrives Under Stress...... 506
  Everybody's Going to Boston........ 406
  Foundrymen 511
  Molding Machines 546
  Prospect and Retrospect................ 38
  Take Advantage of this Opportunity.. 292
  The Open-Door Policy is Best........ 80
  Trade Outlook. 80, 166, 204, 292, 338, 464, 506
  Twenty-five Years of Service.......... 406
  War - The Industrial Crucible........ 338
Effects of Phosphor-Tin and Phosphor-Copper 71
Effects of Seasoning on Gray Iron Castings 435
Eighty-eight-10-2 Alloy.................. 271
Electric-Arc Welding for Foundry Purposes 179
Electric-Arc Welding, Repairing a Large Casting by 120
Electric Boat Co., Vanadium Bronze Submarine Castings 121
Electric Furnace as a Copper-Melting Medium 280
Electric Furnace Construction Co., formed. 398
Electric Furnace in the Steel Casting Plant. 232
Electric Furnace Installations.......... 81
Electric Furnace, Melting All-Scrap in.. 399
Electric Furnace, Melting Malleable Iron in 140
Electric Furnace Power Problems, Solving 459
Electric Furnaces, Magnesite Bottoms for 248
Electric Furnaces, Rennerfelt, Sold...... 231
Electric Furnaces, To Build............ 398
Electric Heating of Crucibles. 194
Electric Motor Drive, Demonstrating the Reliability of 40
Electric Resistance Alloy................ 301
Electric Steel, Acid and Basic, Castings from 220, 269
Electric Steel Output Increases 85 Per Cent 254
Electric Conductivity, Manganese Decreases 461
Electrode, Auxiliary, Employs.......... 466
Elements, Chemical, Melting Points of the ....Data Sheet No. 233, May
Employs Auxiliary Electrode............ 466
Enamels and Japans, Protective Coatings: II 138
Essential Factors in Foundry Cost Accounting 90
Evolution of the Die-Casting Process I 237, 265
Exhibition, Boston, what you will see at the 354
Exhibitors, Boston Show, List of...... 290
Exhibits at Boston Reflect War's Influence 427
Expenses, Operating, Keeping Down in a Small Gray Iron Foundry.......... 215
Experiments with Permanent Molds. 187, 288
Experiments with Sulphur in Copper.. 447

F

Facings for Brass Castings.............. 196
Failure of Brass........................ 114
Federal Foundry Supply Co., Counter-Balanced Cupola Doors................ 465
Federal Foundry Supply Co., Sleeve Valve Molding Machine 409
Federal Malleable Co., Small Squeezer-Type Molding Machine 167
Feeding, Insufficient, Difficulty Due to.... 30
Female Labor, Employment of, in the Foundry 519
Ferro Machine & Foundry Co., How Automobile Motor Castings Are Molded..... 469
Ferro Machine & Foundry Co., How Cores for Motor Car Castings Are Made...... 255
Ferro-Manganese in 1916................ 81
Figuring the Cost of the Cupola Heat..... 102
Finishing, Wax, Bronze.................. 156
Fixtures, Steam Metal.................. 115
Flag-Raising Celebrates Opening of New Plant 407
Flaking, Cause of...................... 447
Flask Equipment, Sensible, for Machine Molding 176
Flask, Molding Frame and.............. 123
Flood Lights in Industries, Use of........ 94
Flux, Aluminum Solders and............ 533
Flux, Cupola, Limestone for............ 118
Flux for Brass Particles................ 196
Flux for Small Brass Particles.......... 157
Flux for Soldering ....
..............Data Sheet No. 243, October
Forgings for Fuse Caps.................. 285
Formulas for the Brass Foundryman......
........Data Sheets Nos. 235 and 236, June
Data Sheets Nos. 235 and 236, June; 241 and 242, September; 243 and 244, October; and 245 and 246, November.
Founding, Steel, Progress of, in 25 Years. 383
Foundries, English, Increased Use of Molding Machines in...................... 37
Foundries, How Profit-Sharing Has Worked in 6
Foundries, Installing a Uniform Cost System in 206
Foundries, Organizing for Welfare Work in 458
Foundry, American, in a Time of War.... 127
Foundry Behind the Automobile.......... 223
Foundry, Brass, Time - Saving Stand for Checking Melting Losses in a.......... 20
Foundry, Brass, What the, Has Done in 25 Years 386
Foundry, Canadian, Casting Chilled Car Wheels in a.......................... 297
Foundry, Cincinnati, for Making Special Castings 527
Foundry Cost Accounting, Essential Factors in 90
Foundry, Designing a Modern, of Moderate Size 43
Foundry Equipment Co. Extends Plant... 105
Foundry Equipment Co., Improved Core Oven 408
Foundry Equipment Manufacture, Progress in 375
Foundry Equipment Plant, New, Flag-Raising Celebrates Opening of.............. 407
Foundry, How The, was Dressed When It Made Its Bow 25 Years Age.......... 370
Foundry, How the Sales Engineer Views the 520
Foundry Industry Leaps Forward........ 501
Foundry Meeting, Spirit of Service Pervades 411
Foundry, New Cleveland Stove, for Maximum Output 307
Foundry, New Converter, for Economical Operation 133
Foundry Industry Has Prepared for War, How the 171
Foundry Lighting Problem, How to Solve 522
Foundry, Malleable Iron, Organizing a, in 90 Days.......................... 515
Foundry Organization, Pattern Shop and. 48
Foundry, Role of Metallography in the... 498
Foundry, Safe Handling of Crucibles in the 316
Foundry, Small Gray Iron, Keeping Down Operating Expenses in a.............. 215
Foundry, Small Malleable, Cost System for 9
Foundry Supply Business, Growth of the.. 378
Foundry, The, Parallels Iron Industry's Progress 372
Foundry Trade, What the War Has in Store for the.......................... 253
Foundry's Quarter Century Survey, Malleable 380
Foundryman, Supplying the. for 25 Years. 382
Foundryman's Viewpoint, Pattern Design from the 37
Foundrymen, Boston Welcomes the Great Army of 343
Foundrymen Can Do to Prevent Hot Boxes, What 111
Foundrymen Display Keen Interest in Boston Show 290
Foundrymen Show Interest in Safety Problems 456
Foundrymen's Convention and Exhibition to be Held at Boston................ 81
French Army, Molding Shells and Grenades for the.......................... 131
Frohman, E. D., Brass Cleaner and Deoxidizer 114
Fuel, Cupola, Oil Residue as a.......... 205
Fuel Oil Briquettes, How, Are Used...... 289
Fuel, Powdered Coal as a, in Malleable Shops—IV 32
Fuller, Benjamin D., Elected President A. F. A. 421
Fundamental Principles of Plate Mounting 147
Furnace, Crude-Oil, Melting in a......... 194
Furnace, Melting, Lining for............ 196
Furnace for Melting Copper-Zinc Alloys.. 514
Furnace, Oil-Fired Malleable, How an, Operates 503
Furnace Oil, Measuring, without Using a Meter 202
Furnace, Open-Flame, for Melting Statuary Bronze 246
Furnaces, Electric, Magnesite Bottoms for 248
Furnaces, Melting, Performance of........ 398
Furnaces, Melting, Sizes of Stack and Flues for 116
Fuse Caps, Forgings for................ 285

G

Gas as Fuel for Melting Alloys.......... 193
Gases, Occluded, Influence of, in Cast Metal 149
Gasoline, Mixture to Hold.............. 196
Gating, Heading and Chilling Steel Castings 304
Gating Malleable Castings, Modern Method of 319
Gating Problem, Troublesome............ 521
Gear Blanks and Bushings, Remedying Brittle 327
Gear Cover Casting, Quick Method of Making a 146
Gear Cutter Bed, 5-Ton, Molding and Coring a 363
General Electric Co., Fool-Proof Electric Switch 509
General Electric Co., New Turbine for Driving Blowers 409
General Industrial Notes.............. 41, 83, 126, 169, 207, 251, 296, 341, 410, 467, 510
Glass, Safety, New Form of.............. 465
Gorham Mfg. Co., Open-Flame Furnace for Melting Statuary Bronze.......... 246
Government Metal, Forging.............. 448
Government Prices for Zinc.............. 231
Grain of Brass, Refining the............ 156
Graphite Production, Increased.......... 263
Gray & Benjamin, Advertising Counsellors 294
Gray Iron Art Work, Making.............. 85
Gray Iron Castings, Artistic, Made by Russian Foundrymen 359
Gray Iron Castings, Effects of Seasoning on 435
Gray Iron Castings, Unique..............
.... Supplement, November
Gray Iron has "Grown" in 25 Years, How 379
Gray Iron, Heat-Resisting 14
Gray Iron Progress in 25 Years.......... 374
Gray Iron Reproductions of Early Artisans' Masterpieces, Remarkable ....
.... Supplement, October
Gray, James H., Magnesite Bottoms for Electric Furnaces 248
Grenades, Molding Shells and, for the French Army 131
Grinding Mills, Cast Iron Balls for....... 14
Grinding Wheel Accidents, Table of Causes of....Data Sheets Nos. 225 and 226, January
Grinding Wheel Standards..............
.,..Data Sheets Nos. 227 and 228, February
Grinding Wheels, Actual Grinding of..... 203
Growth of the Foundry Supply Business.. 378
Guns, Makes Large Iron Mold for........ 188
Gurney Electric Elevator Works, Casting Floor Plate and Bed for a Boring-Mill.. 491
Gurney Electric Elevator Works, Molding and Coring a 5-Ton Gear Cutter Bed.... 363

H

Hamilton & Hansell, Rennerfelt Furnaces Sold 231
Handles, Automobile Door, White Brass for 236
Handpad, Serviceable 206
Hard White Iron for Pipes.............. 502
Hardness, Iron and Phosphorus Cause.... 285
Hardness of Copper Zinc Alloys.......... 155
Hardness of Metals in Service, Testing the 263
Heading, Gating and Chilling Steel Castings 304
Heat-Resisting Gray Iron................ 14
Helmet for Arc Welders.................. 243
Hickory Steel Grip Glove Co., Serviceable Handpad 206
History of Nickel Plating for Stove Decorating 175
Hoists, Resumes Manufacture of.......... 408
Hoists, Small Electric, for Foundries..... 81
Holes, Sulphur, How to Eliminate, in Castings 119
Hooven-Owens-Rentschler Co., How Heavy Ammonia Stills Are Molded............ 107
Hot Boxes, What Foundrymen Can Do to Prevent 111
How an Oil-Fired Malleable Furnace Operates 503
How Automobile Motor Castings Are Molded 469
How Cores for Motor Car Castings Are Made 255
How Fuel Oil Briquettes Are Used....... 289
How Gray Iron has "Grown" in 25 Years. 379
How Heavy Ammonia Stills Are Molded.. 107
How Malleable Iron Has Improved....... 475
How Profit-Sharing Has Worked in Foundries 6
How the Foundry Industry Has Prepared for War 171
How The Foundry was Dressed When It Made Its Bow 25 Years Age............ 370
How the Sales Engineer Views the Foundry 520
How the War Affects Manufacture of Crucibles 494
How to Buy Pattern Lumber Economically 117
How to Eliminate Sulphur Holes in Castings 119
How to Make Chilled Cast Iron Balls..... 288
How to Melt Babbitt Metal.............. 369
How to Mix and Melt Manganese Bronze. 72
How to Prevent Dull Iron................ 318
How to Prevent Pin Holes in Brass Castings 327
How to Use Titanium in Making Steel Castings 15
How Walker Process Reduces Ingot Mold Costs 158
How We May Conserve Our Metal Resources 209
How Zinc-Coated Parts are Tested........ 34
Hydrostatic Test, Castings Subjected to... 283

I

Ideals in Melting Metals................ 193
Illinois Mfg. & Supply Co., Complete Sand-Blasting Room 465
Impellers, Mine Pump.................... 235
Improper Melting Methods................ 283
Improved Sanding Roll for the Patternmaker's Lathe 8
Impurities, Influence of, on Tensile Strength 457

Increased Use of Molding Machines in English Foundries 37
Increasing the Output of the Plating Room 261
Independence Inspection Bureau, Table of Causes of Grinding Wheel Accidents.... ......Data Sheets Nos. 225 and 226, January
Industries, Use of Flood Lights in........ 94
Influence of Design on the Cost of Patterns 33, 301
Influence of Impurities on Tensile Strength 457
Influence of Occluded Gases in Cast Metal 149
Ingot Metal, Oxides in.................. 157
Ingot Mold Costs, How Walker Process Reduces 158
Inspection of Brass and Bronze.......... 532
Inspection of Bronze and Brass Castings. 154
Installing a Uniform Cost System in Foundries 206
Intelligent Use of Nickel-Plating Solutions 333
Introducing Iron Into Manganese Bronze. 71
Iron, All, is Good Iron.................. 14
Iron and Phosphorus Cause Hardness..... 285
Iron Balls, Chilled...................... 321
Iron, Casting, Around a Rigid Center..... 20
Iron, Different Kinds of................. 82
Iron, Dull, How to Prevent.............. 318
Iron, Hard White, for Pipes............. 502
Iron Industry's Progress, THE FOUNDRY Parallels 372
Iron, Introducing, Into Manganese Bronze 71

J

Japans and Enamels, Protective Coatings: —II 138
Journal Bearings, Casting................ 111

K

Keeping Down Operating Expenses in a Small Gray Iron Foundry.............. 215
Keller Pneumatic Tool Co., New Plant of. 398
King, Julius, Optical Co., Helmet for Arc Welders 243
Kranz, W. G., Melting Malleable Iron in Electric Furnace 140

L

Labor Appreciates the Human Element... 524
Labor, Female, Employment of, in the Foundry 519
Lacquers, Protective Coatings:—I........ 103
Ladle, Self-Skimming, for Pouring Steel for Castings 244
Ladle Sleeves and Stoppers.............. 451
Ladoff, Isador, New Method of Making High-Speed Steel 291
Lake Torpedo Boat Co., Specifications for Wood Patterns 269
Large Scrap Melting Cupola............. 462
Lathe Beds, Chill Cracks in.............. 182
Lathe, Patternmaker's, Improved Sanding Roll for 8
Lava Crucible Co., Test of Crucible....... 206
Lead, Difficulties Arising from the Use of. 284
Lead, Segregation of 496
Lenoir Car Works Installs Open Hearth.. 118
Lighting Problem, Foundry, How to Solve 522
Lights, Flood, in Industries, Use of....... 94
Limestone for Cupola Flux............... 118
Lincoln Electric Co., Demonstrating the Reliability of Motor Drive............ 40
Lining for Melting Furnace.............. 196
Link-Belt Co., Molding Sand Revivifier.... 508
Link-Belt Co., Resumes Manufacture of Hoists 408
Locks, Cheap Mixture for................ 157
Loss in Melting......................... 178
Losses in Melting Cast Iron.............. 222
Ludlum Steel Co., Melting All-Scrap in Electric Furnace 399
Lumber, Pattern, How to Buy, Economically 117
Lumber, Pattern, Selection............... 205
Lunkenheimer Co., Cincinnati Foundry for Making Special Castings.............. 527
Lupton's, David, Sons Co., Pond Truss for Buildings 20

Mc

McLain, David, Lenoir Car Works Installs Open Hearth...................... 118

M

Machine for Testing the Hardness of Metals in Service 263
Machine, Screw Counting................ 124
Machinery, Wood-Working, Sizes of Connections for....Data Sheet No. 230, March
Magnalium Castings 196
Magnesite Bottoms for Electric Furnaces. 248
Making Aluminum Match Plates......... 79
Making Cast Iron Shells in Permanent Molds 439
Making Cook Stoves for Uncle Sam's New Army 389
Making Gray Iron Art Work............. 85
Making Large Pure Aluminum Castings.. 98
Making Nonferrous Castings in a Railroad Shop 1
Making Vanadium Bronze 497
Malleable Cast Iron, Shrinkage of....... 19
Malleable Castings, Modern Method of Gating 319
Malleable Castings, Railroad, Tentative Specifications for 295
Malleable Foundry, Small, Cost System for 9
Malleable Foundry's Quarter Century Survey 380
Malleable Furnace, How an Oil-Fired, Operates 503
Malleable Iron and Its Uses............ 505
Malleable Iron, Bronze Substitute for.... 533
Malleable Iron, Casting, in Permanent Molds 40
Malleable Iron Castings, Producing Machinable 449
Malleable Iron Foundry, Organizing a, in 90 Days 515
Malleable Iron Has Improved, How...... 475
Malleable Iron Improves in Quality..... 376
Malleable Iron Manufacture, Progress in. 377
Malleable Iron, Melting, in Electric Furnace 140
Malleable Iron Practice, Use of Chills in 303
Malleable Iron, Pulverized Coal for Melting 487
Malleable Men Discuss Practical Problems 422
Malleable Practice, Removing Traditional Evils of 73, 398
Malleable Shops, Powdered Coal as a Fuel in—IV 32
Manganese Bronze, How to Mix and Melt 72
Manganese Bronze, Introducing Iron Into 71
Manganese Bronze, Properties of......... 272
Manganese Bronze, Unusually Strong.... 31
Manganes Decreases Electrical Conductivity 461
Manganese Steel Castings, Manufacture of 141
Manitowoc Electric Implement Co., Electric Vibrators 39
Manufacture of Manganese Steel Castings 141
Marsh Electric Resistance Alloy......... 301
Match Plates, Aluminum, Making....... 79
Match-Plates, Zinc Alloy for............ 31
Measuring Furnace Oil without Using a Meter 202
Mechanical Purposes, Properties of Bronzes for 68
Melting Alloys, Gas as Fuel for........ 193
Melting All-Scrap in Electric Furnace.. 399
Melting Brass in a Gas-Fired Cupola Furnace 189
Melting Brass in the Cupola............ 496
Melting Capacity of a Small Cupola, To Increase the 291
Melting Cast Iron, Losses in............ 222
Melting Copper in Cupola.............. 195
Melting Down Scrap 29
Melting in a Crude-Oil Furnace........ 194
Melting in a Cupola with Bituminous Coal 67
Melting, Loss in 178
Melting Malleable Iron in Electric Furnace 140
Melting Metals, Ideals in............... 193
Melting Methods, Improper............. 283
Melting Points of the Chemical Elements ....Data Sheet No. 233, May
Melting Practice at the Royal Mint..... 191
Melting, Slow, and Bridging........... 97
Melting with Coal Screenings.......... 156
Melting Yellow Brass, Mixing and....... 116
Metal, Aeroplane 30
Metal, Ajax and Carmelia.............. ....Data Sheet No. 246, Nov.
Metal, Anti-Friction 157
Metal, Anti-Friction, Analyses for...... 284
Metal, Babbitt, How to Melt........... 369
Metal, Benedict, Analysis of............ 72
Metal, Cast, Influence of Occluded Gases in 149
Metal, Cooling, Control of, in Cast Iron Work 302
Metal, Ex. B..Data Sheet No. 245, November
Metal from Brass Concentrates......... 497
Metal, Government, Forging............ 448
Metal, Ingot, Oxides in................ 157
Metal Resources, How We May Conserve Our 209
Metal, Scrap Babbitt, Utilizing......... 236
Metal, Steam, Fixtures 115
Metal, White, for Art Work............ 196
Metallography, Role of, in the Foundry.. 498
Metals and Alloys, Sand-Cast, Results of Tests of 270
Metals, Bearing, Analyses of........... 236
Metals, Ideals in Melting.............. 193
Metals, Nonferrous, Chill Molds for Casting 28
Metals, Weight of Square Foot of Various ....Data Sheet No. 240, August
Meter, Measuring Furnace Oil Without Using a 202
Method of Babbitting Thrust Collars.... 284
Michigan Steel Castings Co., Electric Furnace in the Steel Casting Plant...... 232
Microscope, Metallographic, Application of the 498
Mills, Grinding, Cast Iron Balls for.... 14
Mine Pump Impellers 235
Minnesota Manufacturers' Association, Gravity Conveyors for Foundry Materials 508
Mint, Royal, Melting Practice at the.... 191
Minute Cavities in Brass Castings....... 448
Missouri Malleable Iron Co., How an Oil-Fired Malleable Furnace Operates.. 503
Mixture, Aluminum, for Pistons......... 497
Mixing and Melting Yellow Brass....... 116
Mixture, Bronze, to Resist Acetic Acid.. 236
Mixture, Core Sand, for Globe Valves... 447
Mixture, Cheap, for Locks............. 157
Mixture, Difficult, to Cast............ 115
Mixture, 88-10-2, Tensile Strength of.... 156
Mixture for Aeroplane Motor Castings... 116
Mixture for Aluminum Pistons.......... 31
Mixture for Bronze Parts............... 13
Mixture for Cheap Car Journal Bearings. 70
Mixture for Cylinders.................. 202
Mixture for Oxyacetylene Torch Castings 327
Mixture for Stove Castings............. 452
Mixture for White Metal Patterns....... 326
Mixture of Bronze to Resist Mine Water. 497
Mixture of Iron for Permanent Molds... 398
Mixture of No 31 Aluminum........... 72
Mixture to Hold Gasoline.............. 196
Mixture, Tobin Bronze................. 157
Mixtures, Cheap Red Brass............ 285
Mixtures of Alloys Similar to Duraluminum 284
Modern Methods of Gating Malleable Castings 319
Mold Costs, Ingot, How Walker Process Reduces 158
Mold, Large Iron, for Guns............ 188
Molding a Fan Pedestal, Pattern Economy in 288
Molding and Coring a 5-Ton Gear Cutter Bed 363
Molding Frame and Flask.............. 123
Molding, Hand and Power Machine, Advantages of 285
Molding Job, Difficult Bronze Casting... 234
Molding Machines, Combination Electric Jar-Ramming and Power Rock-Over... 39
Molding Machine, New Type of Roll-Over 507
Molding, Machine, Sensible Flask Equipment for 176
Molding Machine, Sleeve Valve......... 409
Molding Machine, Small Squeezer-Type.. 167
Molding Machines, Hand Squeezer...... 507
Molding Machine, Increased Use of, in English Foundries 37
Molding Operations, "Movies" of....... 121
Molding Sand Gets Right of Way to Oct 15 214
Molding Shells and Grenades for the French Army 131
Molding Wheels and Sheaves with Steel Spokes 99
Molds and Cores, Cast Iron, Use of..... 164
Molds, Chill, for Casting Nonferrous Metals 28
Molds, Permanent, Casting Malleable Iron in 40
Molds, Permanent, Experiments with.187,.288
Molds, Permanent, for Castings, Early Use of 274
Molds, Permanent, Making Cast Iron Shells in 439
Molds, Permanent, Mixture of Iron for.. 398
Molds, Permanent, Progress in Casting Brass in 70
Monarch Engineering & Mfg. Co., Open-Flame Furnace for Melting Statuary Bronze 246
Moore, Edwin A., Iron Foundry, Making Gray Iron Art Work............ 85
Motor Car Castings, How Cores for, Are Made 255
Motor Castings, Aeroplane, Mixture for.. 116
Motor Drive, Demonstrating the Reliability of 40
Mounting, Plate, Fundamental Principles of 147
"Movies" of Molding Operations....... 121

N

National Engineering Co., Equipment for Reclaiming Core Sand................ 293
National Malleable Castings Co., Melting Malleable Iron in Electric Furnace..... 140
National Safety Council, Foundrymen Show Interest in Safety Problems..... 456
New Cleveland Stove Foundry for Maximum Output 307
New Converter Plant for Economical Operation 133
New Foundry Appliance Co., Molding Frame and Flask 123
New London Ship & Engine Co., Designing a Modern Foundry of Moderate Size 43
New Method of Making High-Speed Steel 291
Nickel Alloy, Very Stiff, White.......... ....Data Sheet No. 237, July
Nickel Anodes, Scrap, Reclaimed by Welding 484
Nickel Anodes, Trouble with........... 71
Nickel, Benedict ....Data Sheet No. 238, July
Nickel Plating for Stove Decorating, History of 175
Nickel-Plating Solutions, Intelligent Use of 333
Nitride, Aluminum 497

Nomenclature of Aluminum Alloys....... 285
Nonferrous Metal Resources, How We May Conserve 209
Nonferrous Metal, Some Test Bar Suggestions for 322
Nonferrous Metals, Chill Molds for Casting 28
Nonferrous Metals, Modern Methods of Melting 189
Non-Shrinkable Pattern Alloy.......... 447
Novo Engine, Co. Shares Profits....... 169
No. 12 Aluminum 115

O

Obermayer, S., Co., Brass Cleaner and Deoxidizer 114
OBITUARIES:
  Green, W. W. 294
  Griffith, T. L. 40
  Simpson, Peter Liston.......... 339
Oil-Fired Malleable Furnace, How an, Operates 503
Oil Fuel, Briquettes, How, Are Used... 289
Oil, Furnace, Measuring, Without Using a Meter 202
Oil Residue as a Cupola Fuel.......... 205
Oldham, George, & Son, New Core Buster 249
Open-Flame Furnace for Melting Statuary Bronze 246
Ordnance Construction, Steel Castings for 453, 477
Organization, Pattern Shop and Foundry 48
Organizing for Welfare Work in Foundries 458
Output, Average, of Cupolas.......... ....Data Sheet No. 234, May
Output, Electric Steel, Increases 85 Per Cent 254
Output of the Plating Room, Increasing the 261
Ovens, Annealing, Roof Arch for....... 509
Overcoming Porosity 116
Oxides in Ingot Metal.......... 157
Oxyacetylene Torch Castings, Mixture for 327

P

Palo Co., Testing the Hardness of Metals in Service 263
Parts, Zinc-Coated, are Tested, How..... 34
Pattern Alloy, Non-Shrinkage.......... 447
Pattern Alloy, White Metal.......... 285
Pattern Design from the Foundryman's Viewpoint 37
Pattern Economy in Molding a Fan Pedestal 288
Pattern Lumber, How to Buy, Economically 117
Pattern Lumber Selection.......... 205
Pattern Shop and Foundry Organization.. 48
Pattern, Simple, Constructing a......... 13
Pattern Storage, Systematic, Aids the Foundry 183
Patternmaker of the Hour.......... 162
Patternmaker's Construction Board....... 369
Patternmaker's Work Bench, Top for the 246
Patternmakers, Time-Saving Kink for.... 203
Patterns, Fundamental Principles of Mounting 147
Patterns, Influence of Design on the Cost of 33, 301
Patterns, White Metal, Mixture for...... 326
Patterns, Wood, Specifications for........ 269
Pedestal, Fan, Pattern Economy in Molding a 288
Peerless Foundry Co., Molding Frame and Flask 123
Pennsylvania Railroad Co., Making Nonferrous Castings in a Railroad Shop... 1
Personal 41, 81, 125, 205, 251, 293, 339, 408, 455, 493
Philadelphia Foundrymen Meet 169
Phosphor-Copper and Phosphor-Tin, Effects of 71
Phosphor-Tin and Phosphor-Copper, Effects of 71
Phosphorus and Iron Cause Hardness... 285
Pianos, Making Castings for.......... 285
Pig Iron Production Declined During First Half of Year.......... 387
Pin Holes in Brass Castings, How to Prevent 327
Pipe, Soil, and Fittings, Tentative Specifications for 270
Pipes for Grinding, Polishing, Buffing or Rag Wheels....Data Sheet No. 229, March
Pipes, Hard White Iron for.......... 502
Piston Rings, Brass Alloys for.......... 534
Pistons, Aluminum, Mixture for......... 31
Pistons, Aluminum Mixture for......... 497
Pitted Brass Plungers 31
Pittsburgh Foundrymen's Association, "Movies" of Molding Operations....... 121
Pittsburgh Rolls Corp. Takes Over Seaman-Sleeth Co. 369
Plaster of Paris in the Brass Foundry.. 326
Plate Mounting, Fundamental Principles of 147
Plating, Copper, Aluminum.......... 283
Plating, Nickel-, Solutions, Intelligent Use of 333
Plating Room, Increasing the Output of the 261
Plating Room, Safety in the.......... 58
Plungers, Brass, Pitted.......... 31
Pond Truss for Buildings.......... 20
Porosity, Overcoming 116
Porous Brass and Bronze Sticks........ 31
Porous Brass Castings.......... 29
Porous Copper Castings 195
Powdered Coal as a Fuel in Malleable Shops—IV 32
Power Mfg. Co., Keeping Down Operating Expenses in a Small Gray Iron Foundry 215
Power Problems, Electric Furnace, Solving 459
Pressure, Water, Castings Subjected to.. 327
Prest-O-Lite Co., Inc., Scrap Nickel Anodes Reclaimed by Welding.......... 484
Preventing Accidents in Industrial Yards 461
Preventing Cupola Bridging 310
Prices, Agreed, and Their Meaning....... 511
Prices. Average Monthly, of Foundry Iron, Machinery and Malleable Scrap, Ferro-Manganese and Coke.......... 172
Prices, Government, for Zinc.......... 231
Pridmore, Henry E., Combination Electric Jar-Ramming and Power Rock-Over Molding Machine 39
Principles of Plate Mounting, Fundamental 147
Producing Machinable Malleable Iron Castings 449
Production of Semisteel Shells.......... 337
Profit-Sharing Has Worked in Foundries, How 6
Progress, Gray Iron, in 25 Years....... 374
Progress in Casting Brass in Permanent Molds 70
Progress in Foundry Equipment Manufacture 375
Progress in Malleable Iron Manufacture. 377
Progress in the Manufacture of Steel Castings 325
Progress, Iron Industry's, THE FOUNDRY Parallels 372
Progress of Steel Founding in 25 Years.. 383
Propeller Casting is Essential to Our Defense 366
Properties of Bronze for Mechanical Purposes 68
Properties of Semisteel Castings......... 53
Proprietary Bearing Alloys.......... ..Data Sheets Nos. 245 and 246, November
Protective Coatings: Lacquers—I....... 103
Protective Coatings: Japans and Enamels—II 138
Pulverized Coal for Melting Malleable Iron 487
Pump, Mine, Impellers 235

Q

Quick Method of Making a Gear Cover Casting 146

R

Radiator Cores, Economical 462
Railroad Malleable Castings, Tentative Specifications for 295
Railroad Shop, Making Nonferrous Castings in a.......... 1
Recently Developed Uses of Aluminum in Industry 531
Recommends Standard Screen Scale for Sieves 163
Refining Process, Deoxidizing and, Schwartz 294
Refining the Grain of Brass.......... 156
Remedying Brittle Bushings and Gear Blanks 327
Remelting Shot Iron 52
Removing Aluminum from Brass........ 448
Removing Traditional Evils of Malleable Practice 73, 398
Rennerfelt Furnaces Sold 231
Repairing a Large Casting by Electric Arc Welding 120
Repairing Cracks in Steel Castings Electrically 306
Revivifier, Molding Sand 508
Reynolds Pattern & Machine Co., Screw Counting Machine 124
Richmond Malleable Casting Co., Organizing a Malleable Iron Foundry in 90 Days 515
Role of Metallography in the Foundry... 498
Rolling Mill Bearings.......... 116
Rough and Dirty Yellow Brass Castings. 448

S

Safe Handling of Crucibles in the Foundry 316
Safety Awards Announced.......... 153
Safety in the Plating Room.......... 58
Safety Problems, Foundrymen Show Interest in 456
Sand-Blast Apparatus, New Departure in the Design of.......... 168
Sand-Blast Barrel, Develops Large....... 124
Sand-Blast Machines, Made.......... 263
Sand-Blasting Room, Complete.......... 465
Sand-Cast Metals and Alloys, Results of Tests of 270
Sand, Core, Mixture for Globe Valves... 447
Sand, Molding, Gets Right of Way to Oct. 15 214
Sand, Molding, Revivifier 508
Sand, Preparing, for Steel Foundry Work 526
Sand Problem, Steel Foundry, Study of the 312
Sanding Roll, Improved, for the Patternmaker's Lathe 8
Scale, Standard Screen, for Sieves, Recommends 163
Schwartz Deoxidizing and Refining Process 294
Scrap, All-, Melting, in Electric Furnace. 399
Scrap Babbitt Metal, Utilizing.......... 236
Scrap Melting Cupola, Large.......... 462
Scrap, Melting Down.......... 29
Scrap Nickel Anodes Reclaimed by Welding 484
Scrap, Poor, Trying to Use.......... 30
Scrap, Thin, Rolled Brass, Utilizing...... 236
Screw Counting Machine.......... 124
Seaman-Sleeth Co. is sold and J. S. Seaman Retires 369
Seasoning, Effects of, on Gray Iron Castings 435
Seasoning of Castings.......... 96
Segregation of Lead.......... 496
Selenium in Copper.......... 369
Self-Skimming Ladle for Pouring Steel for Castings 244
Semisteel Castings 248
Semisteel Castings, Properties of......... 53
Semisteel in the last Quarter Century.... 384
Semisteel Shells, Production of.......... 337
Sensible Flask Equipment for Machine Molding 176
Sheaves with Steel Spokes, Molding Wheels and 99
Sheeler-Hemsher Co., Making Large Pure Aluminum Castings 98
Shells and Grenades, Molding, for the French Army 131
Shells, Cast Iron, Making, in Permanent Molds 439
Shells, Semisteel, Production of.......... 337
Shepard Crane & Hoist Co., Small Electric Hoists for Foundries.......... 81
Shot Iron, Remelting.......... 52
Shrinkage and Contraction.......... 5
Shrinkage Difficulties 71, 116
Shrinkage of Malleable Cast Iron........ 19
Shrinkage of Steel Castings, Effect of Copper on 165
Sieves, Recommends Standard Screen Scale for 163
Silberberg, Mortimer J., Motion Study Watch 167
Sizes of Connections for Wood-Working Machinery......Data Sheet No. 230, March
Sizes of Stack and Flues for Melting Furnaces 116
Slag Test for Refractory Brick in Steel Industry 340
Sleeves and Stoppers, Ladle.......... 451
Slings, Belt, for Cores.......... 102
Slow Melting and Bridging.......... 97
Smith, Werner G., Co., Oil for Cores.... 339
Snyder Electric Furnace Co., Electric Furnace Installations 81
Soldering Aluminum Bronze.......... ....Data Sheet No. 244, October
Soldering Aluminum-Bronze Castings 284
Soldering, Flux for ....Data Sheet No. 243, October
Solders and Flux, Aluminum.......... 533
Solution, Cleaning, for Brass Castings.... 30
Solutions, Nickel-Plating, Intelligent Use of 333
Solving Electric Furnace Power Problems 459
Some Test Bar Suggestions for Nonferrous Metal 322
Specifications for Wood Patterns......... 269
Specifications, Tentative, for Brass Castings 446
Specifications, Tentative, for Railroad Malleable Castings 295
Specifications, Testing Society Considers New 270
Spirit of Service Pervades Foundry Meeting 411
Stand, Time-Saving, for Checking Melting Losses in a Brass Foundry.......... 20
Standard Foundation Washers.......... ....Data Sheet No. 231, April
Standard Screen Scale for Sieves, Recommends 163
Standard Steel Castings Co., Large Foundry to Produce Cast Steel Truck Wheels 445
Standard Wood Washers.......... ....Data Sheet No. 232, April
Standards, Grinding Wheel.......... ...Data Sheets Nos. 227 and 228, February
Stark, Charles J., Appointed Editor of *The Iron Trade Review*.......... 119
Steam Metal Fixtures.......... 115
Steel, Acid and Basic Electric, Castings from 220, 269
Steel Casting Plant, Electric Furnace in the 232
Steel Casting Specifications, Navy Revises 318
Steel Castings, Cores for.......... 246

Steel Castings, Effect of Copper on Shrinkage of ... 169
Steel Castings for Ordnance Construction ...453, 477
Steel Castings, Heading, Gating and Chilling ... 304
Steel Castings, How to Use Titanium in Making ... 15
Steel Castings, Manganese, Manufacture of ... 141
Steel Castings, Output of ... 254
Steel Castings, Progress in the Manufacture of ... 328
Steel Castings, Repairing Cracks in, Electrically ... 306
Steel Foundry Work, Preparing Sand for. 526
Strauss & Buegeleisen, New Form of Safety Glass ... 465
Strength, Calculating Tensile from Transverse ... 445
Strength of Chains ... Data Sheet No. 239, August
Strength, Tensile, Influence of Impurities on ... 457
Strength, Varying, in Different Parts of a Large Casting ... 305
Strong Aluminum Alloys ... 327
Strong Castings ... 165
Strong, Kennard & Nutt Co., Can't Splinter New Lens ... 547
Study of Inclusions of Alumina in Steel.. 197
Study of the Steel Foundry Sand Problem ... 312
Sturtevant, B. F., Co., Cubic Feet of Air Handled through Average Dust-Collecting Hoods and Pipes for Grinding, Polishing, Buffing or Rag Wheels ... Data Sheet No. 229, March
Sturtevant, B. F., Co., Sizes of Connections for Wood-Working Machinery ... Data Sheet No. 230, March
Submarine Castings, Vanadium Bronze... 121
Suggestions for Melting Brass ... 495
Sullivan Machinery Co., Air Compressor for Foundry Use ... 168
Sulphur Holes in Castings, How to Eliminate ... 119
Sulphur in Copper, Experiments with ... 447
Sulphur, Use of an Excess of ... 71
Supplying the Foundryman for 25 Years. 382
Surface, Bright, Smooth, on Castings.... 79
Switch, Fool-Proof Electric ... 509
Systematic Pattern Storage Aids the Foundry ... 183
Steel for Castings, Self-Skimming Ladle for Pouring ... 244
Steel Founding, Progress of, in 25 Years. 383
Steel Foundry Sand Problem, Study of the ... 312
Steel, High-Speed, New Method of Making ... 291
Steel Industry, Slag Test for Refractory Brick in ... 340
Steel Sessions Draw Big Crowds ... 420
Steel Spokes, Molding Wheels and Sheaves with ... 99
Steel, Study of Inclusions of Alumina in. 197
Steel Wheels, Casting, for Motor Trucks. 61
Stevens, Frederic B., Again Dips His Pen 398
Sticks, Brass and Bronze, Porous ... 31
Stills, Heavy Ammonia, Are Molded, How 107
Stoppers, Ladle Sleeves and ... 451
Storage Bins, Durable, Design for ... 502
Storage, Systematic Pattern, Aids the Foundry ... 183
Stove Castings, Mixture for ... 452
Stove Decorating, History of Nickel Plating for ... 175
Stove Foundry for Maximum Output, New Cleveland ... 307
Stove Manufacture, Early, in the United States ... 247
Stoves, American Heating, Early Types of 336
Stoves, Cook, for Uncle Sam's New Army, Making ... 389

T

Table of Causes of Grinding Wheel Accidents ... Data Sheets Nos. 225 and 226, January
Ten Per Cent Aluminum Bronze ... 273
Tennessee Coal, Iron & Railroad Co., How Walker Process Reduces Ingot Mold Costs ... 158
Tensile Strength of 88-10-2 Mixture ... 156
Tentative Specifications for Brass Castings 446
Test Bar Suggestions for Nonferrous Metal, Some ... 322
Test, Hydrostatic, Castings Subjected to. 283
Tested, How Zinc-Coated Parts are ... 34
Testing Society Considers New Specifications ... 270
Testing the Hardness of Metals in Service 263
Tests, Aluminum-Bronze, and Their Significance ... 21
Time-Saving Kink for Rush Job ... 203
Time-Saving Stand for Checking Melting Losses in a Brass Foundry ... 20
Tin, Phosphor-, and Phosphor-Copper, Effects of ... 71
Titanium and Aluminum Bronze ... 505
Titanium Bronze Co., Titanium and Aluminum Bronze ... 505
Titanium, How to Use, in Making Steel Castings ... 15
To Increase the Melting Capacity of a Small Cupola ... 291
To Reduce Combined Carbon ... 47
Tobin Bronze ... 115
Tobin Bronze Mixture ... 157
Top for the Patternmaker's Work Bench. 246
Trade Notes ...125, 205, 466
Trade Publications ...42, 170, 208, 252, 342, 410, 468
Transportation and Conveying Problems, Foundry, Solving ... 535
Travelers Insurance Co., Safe Handling of Crucibles in the Foundry ... 316
Trouble with Nickel Anodes ... 71
Trucks, Motor, Casting Steel Wheels for. 61
Truss, Pond, for Buildings ... 20
Trying to Use Poor Scrap ... 30
Turbine, New, for Driving Blowers ... 409
Turnings, Copper, Utilizing ... 283

U

Unique Gray Iron Castings ... Supplement, November
United States Bureau of Standards, Melting Points of the Chemical Elements.. ... Data Sheet No. 233, May
United States Bureau of Standards, The Failure of Brass ... 114
United States Navy Revises Steel Casting Specifications ... 318
United States Silica Co., Little Journeys of the Flint Shot Man ... 504
Unusually Strong Manganese Bronze ... 31
Use of an Excess of Sulphur ... 71
Use of Cast Iron Molds and Cores ... 164
Use of Chills in Malleable Iron Practice. 303
Use of Chills in Producing Sound Castings 302
Use of Flood Lights in Industries ... 94
Utilizing Copper Turnings ... 283
Utilizing Scrap Babbitt Metal ... 236
Utilizing Thin, Rolled Brass Scrap ... 236

V

Valves, Globe, Core Sand Mixture for.... 447
Vanadium Bronze, Making ... 497
Vanadium Bronze Submarine Castings.... 121
Varying Strength in Different Parts of a Large Casting ... 305
Vibrator Operation, Care to be Exercised in ... 249
Vibrators, Electric ... 39
Vickers, Charles, Metallurgical Editor of THE FOUNDRY ... 251

W

Wagner Fire Brick Co., Brick Made from Ashes ... 248
Walker & Pratt Mfg. Co., Making Cook Stoves for Uncle Sam's New Army.... 389
Walker Process Reduces Ingot Mold Costs, How ... 158
War Has in Store for the Foundry Trade, What the ... 253
War, How the Foundry Industry Has Prepared for ... 171
Washers, Standard Foundation ... Data Sheet No. 231, April
Washers, Standard Wood ... Data Sheet No. 232, April
Watch, Motion Study ... 167
Watson, T. H., & Co., To Build Electric Furnaces ... 398
Wax-Finishing Bronze ... 156
Weight of Square Foot of Various Metals ... Data Sheet No. 240, August
Weight of the Coke Bed, Determining Proper ... 132
Welding Copper ... 115
Welding, Electric-Arc, for Foundry Purposes ... 179
Welding, Electric Arc, Repairing a Large Casting by ... 120
Welding Institute Established ... 387
Welding, Scrap Nickel Anodes Reclaimed by ... 484
Welfare Work in Foundries, Organizing for ... 458
West Steel Casting Co., Casting Steel Wheels for Motor Trucks ... 61
Western Electric Co., Use of Flood Lights in Industries ... 94
Westinghouse Electric & Mfg. Co., Systematic Pattern Storage Aids the Foundry ... 183
Westinghouse Electric & Mfg. Co. Will Build ... 105
What Foundrymen Can Do to Prevent Hot Boxes ... 111
What the Brass Foundry Has Done in 25 Years ... 386
What the War Has in Store for the Foundry Trade ... 253
Wheels and Sheaves with Steel Spokes, Molding ... 99
Wheels, Grinding, Polishing, Buffing or Rag, Pipes for..Data Sheet No. 229, March
Wheels, Steel, Casting, for Motor Trucks 61
White Aluminum Alloy ... 196
White Brass Alloy ... 72
White Brass for Automobile Door Handles 236
White Metal for Art Work ... 196
White Metal Pattern Alloy ... 285
White Metal Patterns, Mixture for ... 326
Wire Drawing Blocks ... 71
Woodison, E. J., Co., Flag-Raising Celebrates Opening of New Plant ... 407

Y

Yards, Industrial, Preventing Accidents in ... 461
Yellow Brass, Mixing and Melting ... 116

Z

Zinc Alloy for Match-Plates ... 31
Zinc-Coated Parts are Tested, How ... 34
Zinc, Copper, Alloys, Hardness of ... 155
Zinc, Government Prices ... 231

Authors' Index to Volume XLV

January---December, 1917

A

Adam, H., Making Aluminum Match Plates ... 79
Anderson, Robert J., The Role of Metallography in the Foundry ... 498
Ashe, S. W., Organizing for Welfare Work in Foundries ... 458
Atwater, H. R., How the Sales Engineer Views the Foundry ... 520

B

Backert, A. O., THE FOUNDRY Parallels Iron Industry's Progress ... 372
Baltes, H. A., Repairing a Large Casting by Electric Arc Welding ... 120
Barclay, Harry H., Care to be Exercised in Vibrator Operation ... 249
Bean, W. R., Pulverized Coal for Melting Malleable Iron ... 487
Bell, M. L., and C. E. Nesbitt, Slag Test for Refractory Brick in Steel Industry. 340
Bennett, F. G., Preventing Accidents in Industrial Yards ... 461
Bowers, B. W., Repairing Cracks in Steel Castings Electrically ... 306
Brook, S. B., Gas as Fuel for Melting Alloys ... 193
Broughall, E. H., Experiments with Permanent Molds ...187, 288
Bull, R. A., Progress of Steel Founding in 25 Years ... 383

C

Capp, J. A., Strength and Elongation of Manganese Bronze ... 272
Carrick, R., Advantages of Hand and Power Machine Molding ... 285
Carson, George M., Weight of Square Foot of Various Metals ... Data Sheet No. 240, August
Childs, George W., Design for Durable Storage Bins ... 502
Childs, George W., Standard Foundation Washers ... Data Sheet No. 231, April
Childs, George W., Standard Wood Washers ... Data Sheet No. 232, April
Churchill, W. L., Employment of Female Labor in the Foundry ... 519
Clamer, G. H., Physical Properties of Manganese Bronze ... 272
Clarke, R. R., Electric-Arc Welding for Foundry Purposes ... 179
Clarke, R. R., Fundamental Principles of Plate Mounting ... 147
Clarke, R. R., Troublesome Gating Problem ... 521

Clarke, Russell R., What Foundrymen Can Do to Prevent Hot Boxes......... 111
Clewell, C. E., How to Solve a Foundry Lighting Problem 522
Coleman, F. A., Average Output of Cupolas............Data Sheet No. 234, May
Comstock, G. F., and W. M. Corse, Aluminum-Bronze Tests and Their Significance 21
Comstock, George F., Study of Inclusions of Alumina in Steel.................. 197
Cook, S. L., Improved Sanding Roll for the Patternmaker's Lathe............. 8
Corse, W. M., and G. F. Comstock, Aluminum-Bronze Tests and Their Significance 21
Corse, W. M., Ten Per Cent Aluminum Bronze 273
Crosby, Edwin L., Solving Electric Furnace Power Problems.................. 459
Custer, Edgar Allen, Chilled Iron Balls.. 321
Custer, Edgar Allen, Making Cast Iron Shells in Permanent Molds............ 439
Custer Jr., Edgar Allen, How to Eliminate Sulphur Holes in Castings.......... 119
Custer Jr., Edgar Allen, The American Foundry in a Time of War........... 127

D

Dietz, John M., Melting in a Cupola with Bituminous Coal 67
Duggan, M. E., Constructing a Simple Pattern 13
Duggan, M. E., Influence of Design on the Cost of Patterns.................. 301
Duggan, M. E., Pattern Design from the Foundryman's Viewpoint 37
Duggan, M. E., Patternmaker's Construction Board 369
Duggan, M. E., Time-Saving Kink for Rush Job 203
Duggan, M. E., Top for the Patternmaker's Work Bench..................... 246
Dunbar, Howard W., Do Grinding Wheels Actually Grind? 203

E

Eastham, John H., Pattern Economy in Molding a Fan Pedestal.............. 288
Estep, H. Cole, How to Buy Pattern Lumber Economically 117

F

Fletcher, J. E., Influence of Occluded Gases in Cast Metal.................. 149
Flinn, Alfred D., and Ernest Jonson, Inspection of Brass and Bronze.......... 532
Flinterman, R. F., Electric Furnace in the Steel Casting Plant............... 232
Fraser, A., Heading, Gating and Chilling Steel Castings 304
Fraser, A., Use of Chills in Malleable Iron Practice 303
Fulton, A. M., Modern Methods of Gating Malleable Castings................ 319

G

Goostray, Joseph, Patternmaker of the Hour 162
Gray, C. E., Casting Chilled Car Wheels in a Canadian Foundry............... 297
Greenwood, H. C., and R. S. Hutton, Electric Heating of Crucibles.......... 194
Gulick, H. S., Properties of Bronzes for Mechanical Purposes 68

H

Harrington, Joseph, Powdered Coal as a Fuel in Malleable Shops—IV.......... 32
Hartley, H., and H. M. Thornton, Melting Brass in a Gas-Fired Cupola Furnace 189
Hering, Carl, Ideals in Melting Metals... 193
Hill, John, Supplying the Foundryman for 25 Years 382
Hocking, W. J., Melting Practice at the Royal Mint 191
Howell, J. J., Control of Cooling Metal in Cast Iron Work.................. 302
Howell, J. J., Experiments with Permanent Molds 187, 288
Hutton, R. S., and H. C. Greenwood, Electric Heating of Crucibles.......... 194

J

Janssen, W. A., How to Use Titanium in Making Steel Castings................ 15
Jeffery, A. T., Producing Machinable Malleable Iron Castings................ 449
Jones, G. E., Does Copper Affect Shrinkage of Steel Castings?................ 165
Jones, J. L., Aluminum 92 Per Cent and Copper, 8 Per Cent.................. 273
Jones, J. L., Conductivity and Hardness of Manganese Bronze................ 272
Jonson, Ernest, and Alfred D. Flinn, Inspection of Brass and Bronze........ 532
Jonson, Ernst, Inspection of Bronze and Brass Castings 154

K

Keep, W. J., All Iron is Good Iron...... 14
Keep, W. J., Bright, Smooth Surface on Castings 79
Keep, W. J., Calculating Tensile from Transverse Strength 445
Keep, W. J., Casting Iron Around a Rigid Center 20
Keep, W. J., Castings with a White Core 130
Keep, W. J., Chill Cracks in Lathe Beds 182
Keep, W. J., Chilled Castings from a Cupola Running Gray Iron........... 188
Keep, W. J., Chilling Mine Car Wheels. 315
Keep, W. J., Cupola Charging.......... 93
Keep, W. J., Determining Proper Weight of the Coke Bed........................ 132
Keep, W. J., Different Kinds of Iron.... 82
Keep, W. J., Early Stove Manufacture in the United States...................... 247
Keep, W. J., Early Types of American Heating Stoves 336
Keep, W. J., Figuring the Cost of the Cupola Heat 102
Keep, W. J., Gray Iron Progress in 25 Years 374
Keep, W. J., Hard White Iron for Pipes. 502
Keep, W. J., Heat-Resisting Gray Iron.. 14
Keep, W. J., History of Nickel Plating for Stove Decorating 175
Keep, W. J., How to Make Chilled Cast Iron Balls 288
Keep, W. J., How to Prevent Dull Iron. 318
Keep, W. J., Influence of Impurities on Tensile Strength 457
Keep, W. J., Limestone for Cupola Flux. 118
Keep, W. J., Loss in Melting............ 178
Keep, W. J., Losses in Melting Cast Iron 222
Keep, W. J., Mixture for Cylinders...... 202
Keep, W. J., Mixture for Stove Castings. 452
Keep, W. J., Preventing Cupola Bridging 310
Keep, W. J., Remelting Shot Iron....... 52
Keep, W. J., Semisteel Castings......... 248
Keep, W. J., Slow Melting and Bridging 97
Keep, W. J., Strong Castings........... 165
Keep, W. J., to Increase the Melting Capacity of a Small Cupola............. 291
Keep, W. J., to Reduce Combined Carbon 47
Keep, W. J., Varying Strength in Different Parts of a Large Casting.......... 305
Kent, J. F., Labor Appreciates the Human Element 524
Kihn, William J., Casting Floor Plate and Bed for a Boring Mill.............. 491
Kihn, William J., Molding and Coring a 5-Ton Gear Cutter Bed................ 363
Knoeppel, C. E., How Profit-Sharing Has Worked in Foundries 6
Kreutzberg, E. C., Making Gray Iron Art Work 85

L

Lamont, Robert P., Progress in the Manufacture of Steel Castings......... 328
Later, E. P., How Zinc-Coated Parts are Tested 34
Later, E. P., Increasing the Output of the Plating Room..................... 261
Later, E. P., Intelligent Use of Nickel-Plating Solutions 333
Later, E. P., Protective Coatings: Japans and Enamels—II 138
Later, E. P., Protective Coatings: Lacquers—I 103
Later, E. P., Safety in the Plating Room 58
Leafstrom, John, Influence of Design on the Cost of Patterns................... 33
Lorenz, A. Walter, Castings from Acid and Basic Electric Steel...........220, 269

Mc

McCaslin, H. J., Shrinkage and Contraction 5
McKee, W. S., Manufacturer of Manganese Steel Castings.................. 141
McLain, David, Production of Semisteel Shells 337
McLain, David, Semisteel in the last Quarter Century 384
McLain, David, The Properties of Semisteel Castings 53
McNaughton, M., How the War Affects Manufacture of Crucibles............. 494

M

Meneghim, Domenico, Hardness of Copper Zinc Alloys 155
Moldenke, Richard, Casting Malleable Iron in Permanent Molds 40
Moldenke, Richard, Malleable Foundry's Quarter Century Survey.............. 380
Moldenke, Richard, Seasoning of Castings 96
Moldenke, Richard, Shrinkage of Malleable Cast Iron 19
Moore, Frederick C., A Cost System for a Small Malleable Foundry............ 9
Muntz, G., and E. Roubien, Study of the Steel Foundry Sand Problem.......... 312

N

Near, N. G., Strength of Chains.................Data Sheet No. 239, August
Nesbitt, C. E., and M. L. Bell, Slag Test for Refractory Brick in Steel Industry 340
Newcomb, Robert E., Solving Foundry Transportation and Conveying Problems 535

O

Olmstead, G. C., Economical Radiator Cores 462
Orbison, J. B., Cast Iron Balls for Grinding Mills 14
Outerbridge Jr., Alexander E., Early Use of Permanent Molds for Castings..274, 398
Outerbridge Jr., Alexander E., How Gray Iron has "Grown" in 25 Years........ 379

P

Pack, Charles W., Evolution of the Die-Casting Process 237, 265
Palmer, R. H., Molding Wheels and Sheaves with Steel Spokes............. 99
Palmer, R. H., Propeller Casting is Essential to Our Defense................ 366
Patch, N. K. B., Properties of Manganese Bronze 272
Patch, N. K. B., Properties of the 80-10-10 Alloy 272, 311
Penton, John A., How THE FOUNDRY was Dressed When It Made Its Bow 25 Years Ago 370
Perkins, F. M., Pattern Shop and Foundry Organization 48
Pero, J. P., Progress in Malleable Iron Manufacture 377
Pope, Henry F., Malleable Iron and Its Uses 505
Primrose, H. C., Melting in a Crude-Oil Furnace 194

R

Ramp, Paul R., Sensible Flask Equipment for Machine Molding............. 76
Ramp, Paul R., Use of Cast Iron Molds and Cores 164
Roubien, E., and G. Muntz, Study of the Steel Foundry Sand Problem.......... 312

S

Sawhill, R. V., Melting All-Scrap in Electric Furnace 399
Scovell, Clinton H., Essential Factors in Foundry Cost Accounting............. 90
Shaner, E. L., Making Cook Stoves for Uncle Sam's New Army............... 389
Shaner, E. L., Making Nonferrous Castings in a Railroad Shop............... 1
Shea, J. F., Specifications for Wood Patterns 269
Sherwin, L. M., Effects of Seasoning on Gray Iron Castings.................. 435
Shull, F. G., Recently Developed Uses of Aluminum in Industry................ 531
Stevens, Frederic B., Growth of the Foundry Supply Business 378

T

Thornton, H. M., and H. Hartley, Melting Brass in a Gas-Fired Cupola Furnace 189
Tonkin, E., Measuring Furnace Oil Without Using a Meter.................... 202
Tonkin, E., Time-Saving Stand for Checking Melting Losses in a Brass Foundry 20
Touceda, Enrique, How Malleable Iron Has Improved 475
Touceda, Enrique, Malleable Iron Improves in Quality 376
Townsend, C. D., Boilers Reclaim Melting Furnace Heat...................... 525

V

Vickers, Charles, Difficult Bronze Casting Molding Job 234
Vickers, Charles, Electric Furnace as a Copper-Melting Medium 280
Vickers, Charles, How We May Conserve Our Metal Resources 209
Vickers, Charles, Some Test Bar Suggestions for Nonferrous Metal............ 322
Vickers, Charles, What the Brass Foundry Has Done in 25 Years............. 386

W

Wallbank, E. W., A Quick Method of Making a Gear Cover Casting......... 146
Watson, E. L., Pattern Lumber Selection 205
Webbert, L. P., 88-10-2 Alloy.......... 271
Wesson, Major C. M., Steel Castings for Ordnance Construction 453, 447
Whiting, J. H., Progress in Foundry Equipment Manufacture 375

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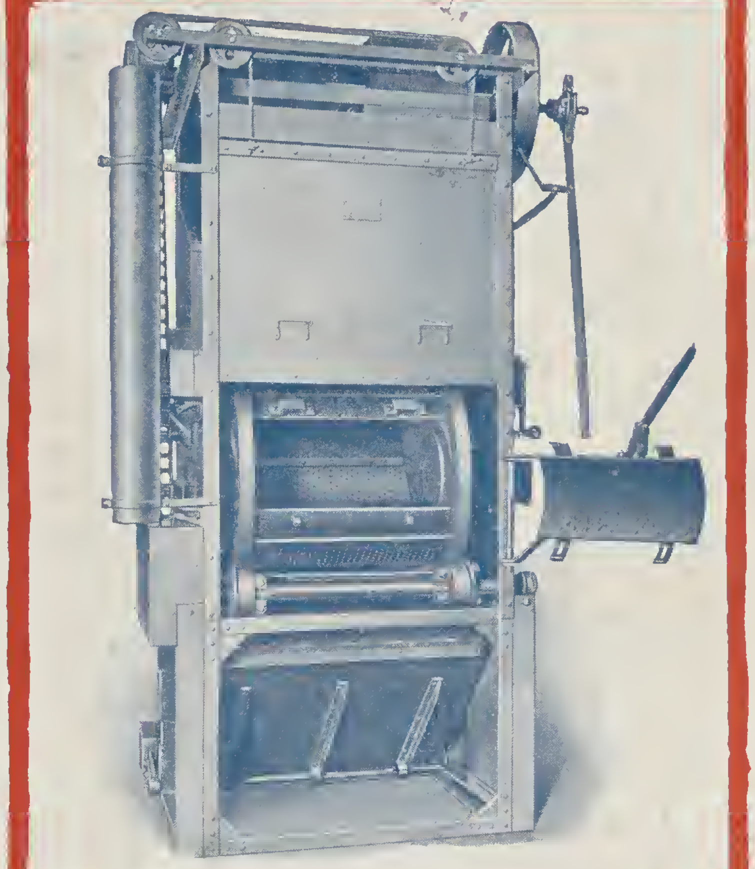

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Alphabetical list of Advertisers, page170
"Where to Buy", page 110

Table of Contents, page 546
Classified Advertisements, page 164

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Reading Foundry & Supply Co.,
Reading, Pa.
Morrison Foundry Co.,
Newark, New Jersey.
Damascus Bronze Co.,
Pittsburgh, Pa.
Bethlehem Steel Co.,
Steelton, Pa.
Hall Steam Pump Co.,
Pittsburgh, Pa.
Epping Carpenter Pump Co.,
Pittsburgh, Pa.
Locomotive Stoker Co.,
Pittsburgh, Pa.
Pittsburgh Lamp & Brass Co.,
Pittsburgh, Pa.
The Alloy Foundry Co.,
Cuyahoga Falls, Ohio.
Amer. Wood Working Mch. Co.,
Rochester, New York.
Henry Wray & Son, Inc.,
Rochester, New York.

We Guarantee the Following Results for Our Oil. What do you claim for your Core Oil and Linseed Oil? We claim cores made from our SUPERIOR GRADE "A" will not swell, crack, buckle, crumble nor absorb any moisture. Makes very little gas when in baking. Cores clean out very easily, leaving a nice, smooth casting, so much desired by all Foundry men, and our oils bind as much as Pure Linseed Oil in every respect, and bakes faster and in uniform.

Can you beat it for 80c A GALLON 1/10 days or 30 days net

AMERICAN OIL REFINING CO., Inc.

1482 BROADWAY, NEW YORK
Suite 603 *Telephone, Bryant 1567*

THE HILL & GRIFFITH CO.
FOUNDRY FACINGS and SUPPLIES

Dependable as a Liberty Bond

"This registered Trade Mark is your guaranty"

KORO

BLACKING

For Dry Sand—Core or Loam Work

Remains in Suspension Longer—Easily Applied—Covers More Surface—Peels Nicely—Imparts Desired Color Which Can Be Proved By Service Test

Measured by its benefits to your foundry it's the cheapest you can buy—Do the Missouri Act—demand to be shown—Order a trial barrel strictly on approval.

Manufactured By

The Hill & Griffith Company
CINCINNATI, O.
CHICAGO, ILL. BIRMINGHAM, ALA. PITTSBURGH, PA.

We Cover Every Foundry Requirement Including

Haskins Patent Ventilated and Peerless Perforated Chaplets

WRITE FOR SAMPLES

"We Sell Glutrin"

CORE OIL PARTING

Foundrymen's Profits

are made from perfect castings not good looking cores. Most Core Oil manufacturers are working with the idea of binding sand without regard for actual results in perfect castings or effect of core binder on liquid metal.

"Cataract" Core Oil will bind more sand and give less trouble in core room and foundry. Insures a higher percentage of perfect castings.

Replaces Linseed Oil, gives better results as it allows shrinkage and leaves the castings freely with a clean, smooth surface.

Absolute proof against cracked castings and blow holes. Don't be satisfied until we have had a chance to show your losses from core trouble can be cut in two.

"Cataract" Parting is made from the best materials, will always give a clean lift and increase production. Light in weight and color, will not stick or gum patterns.

The manufacture of every gallon of our core oil and every pound of parting is guided by the fundamental policy: That standard of quality must be maintained. We employ practical salesmen who will demonstrate the efficiency of our products if you will give us the opportunity.

Cataract Refining & Manufacturing Co.

Plants
Buffalo — Chicago
Eastern Department
17 Battery Place, New York
Western Department
327 La Salle Street, Chicago

General Offices
Marine National Bank Building
BUFFALO, N. Y.

Warehouses
New York
Boston
Detroit
Pittsburgh
San Francisco
Toronto
London, Eng.

KELLY CRYSTAL BLACKING

THE EQUAL OF ANY LEAD ON
DRY SAND OR LOAM WORK
WHERE A WET BLACKING IS USED.
UNEXCELLED AS A CORE WASH.

Price 2c Lb. Freight allowance up to 25c cwt.

ORDER A BARREL ON APPROVAL

EQUIPMENT **SUPPLIES**

KELLY FACINGS
GUARANTEE
CLEAN CASTINGS

ESTABLISHED 1885

T. P. KELLY & CO., INC.
(THE KELLY GRAPHITE MILLS)
"THE FACING SPECIALISTS"
355 WEST 26th STREET
NEW YORK

BRANCHES
CHICAGO, ILL.
HAMILTON, O.
PHILADELPHIA

MILLS
IRWIN, PA.
STOCKERTOWN, PA.

EASTERN AND WESTERN DISTRIBUTORS OF "GLUTRIN"

U.S.G.CO'S.

Mexican Plumbago

We Guarantee Our Facings

because we know what is in them. We take the plumbago from our own mines in Mexico and refine it in our own factory at Saginaw. Then we insure your getting it at minimum price by selling it to you direct without paying a cent of profit to any middleman or agency. And because of the fact that we have our enormous mines to pick the ore from we can maintain the quality absolutely uniform year in and year out.

If you want smooth, well finished castings don't take a chance by using "any old kind" of facing—use a plumbago that will peel your castings perfectly—that's U. S. G. CO.'S MEXICAN PLUMBAGO.

Large stock of different grades on hand ready for prompt shipment. Anticipate your needs and protect yourself against a rising market by ordering now.

The United States Graphite Co.
SAGINAW, MICH., U. S. A.
BRANCH OFFICES:
New York Philadelphia Atlanta Pittsburgh
Chicago Denver St. Louis San Francisco

FLOUR and MOLASSES are used in great quantities for food. ¶ Also they are used in very large quantities as adhesives in foundry work.

They are both, at this time, very costly propositions when used for either purpose.

Any reduction in their use for other purposes than food would, of course, tend to reduce the cost of living.

We believe that such large quantities of both are used in the foundries of this country that their abandonment for foundry purposes would greatly increase our food supply even if it did not perceptibly reduce the cost.

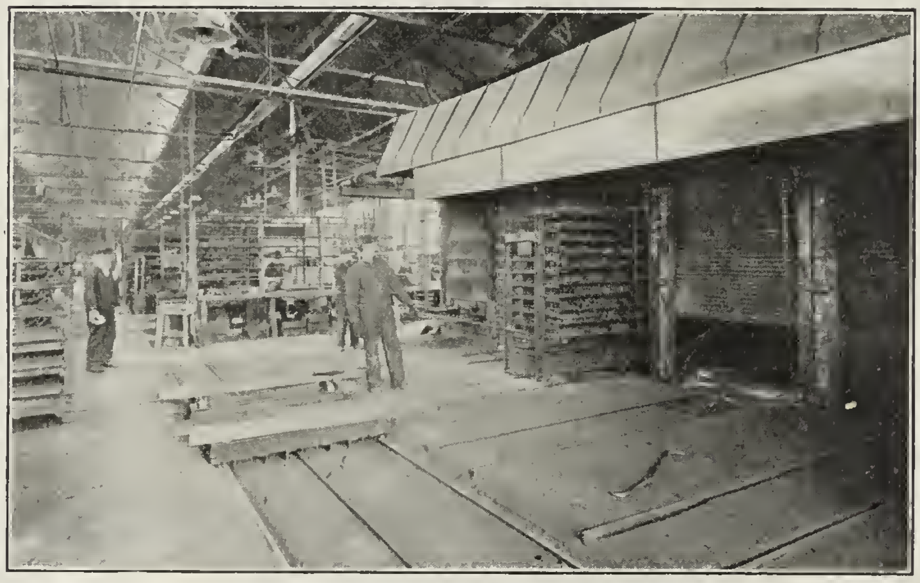
Of course, if foundries abandon the use of these two materials, they must have an efficient substitute; this is found in glutrin, which, measure for measure, is much stronger and much cheaper than either flour or molasses, and does not, in any sense, cut any figure whatever as a food product.

We will, upon request, be glad to send a working sample of glutrin by express prepaid and without charge for the material.

Robeson Process Company
General Offices
18 East 41st Street, New York City

WOODSEED—The Practical Liquid Core Compound

TYPE 57 STANDARD SEVEN-PASSENGER CADILLAC CAR



CORE ROOM OF CADILLAC MOTOR CAR CO.

VIEW IN FOUNDRY OF CADILLAC MOTOR CAR CO.

"Made in the house that WOODISON built"

Used in the car that CADILLAC builds

The Cadillac Motor Car Co., uses WOODSEED because they must maintain a high standard of workmanship in the Cadillac car.

They use only the very best materials in its construction and one of the most important of these is "Woodseed" the *best* liquid core compound to be had.

"Woodseed" is best on automobile cylinder work and *on all classes of cored work*—heavy, light, medium.

A trial barrel to you—sufficient proof that it will accomplish the results desired of Linseed Cored work but at lower cost.

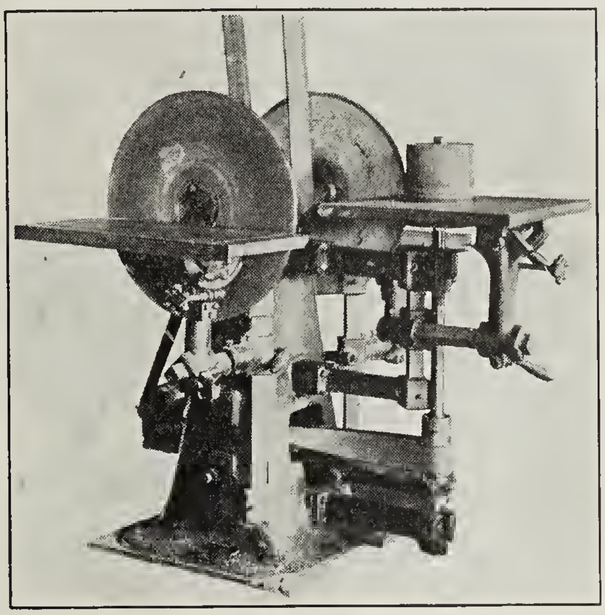
Pay for the barrel only after we've shown results.

Order Now

The E. J. WOODISON COMPANY, Detroit

Boston Buffalo Cleveland Indianapolis St. Louis Seattle Montreal, Que. Toronto Windsor, Ont.

"Made in the House that WOODISON built"



Three men can work on one

DOWNER GRINDER

at the same time

and they will not interfere one with the others.

It is, without doubt, the most completely adjustable machine for the pattern maker or wood worker on the market today.

Such work as ribs, hubs, brackets, etcetera, or in fact any regular or irregular shape can be readily ground to dimensions by the use of the Downer Grinder.

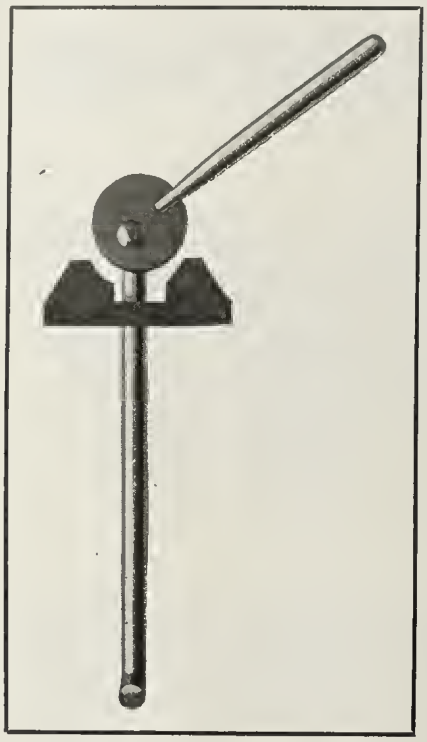
One feature of the Downer, that no other machine possesses, is that the vertical drum can readily be removed and attached to the main arbor. When in that position it has the advantage of having a table underneath, adjustable to any thickness or angle. This makes it equivalent to putting the work through a planer, with the advantage that the tables can be adjusted to grind the work parallel on both sides or to any desired level.

The Downer Grinder is the only one that has a vertical drum in connection with two double-sided discs; is the only grinder with a drum that has a vertical and revolving motion simultaneously, thus banishing all possibility of work becoming scored, as it grinds absolutely smooth.

Let us tell you more about this wonderful little machine. It'll save you money.

WRITE TODAY!

The E. J. WOODISON COMPANY, Detroit
Boston Buffalo Cleveland Indianapolis St. Louis Seattle Montreal, Que. Toronto Windsor, Ont.



"Made in the House that WOODISON built"

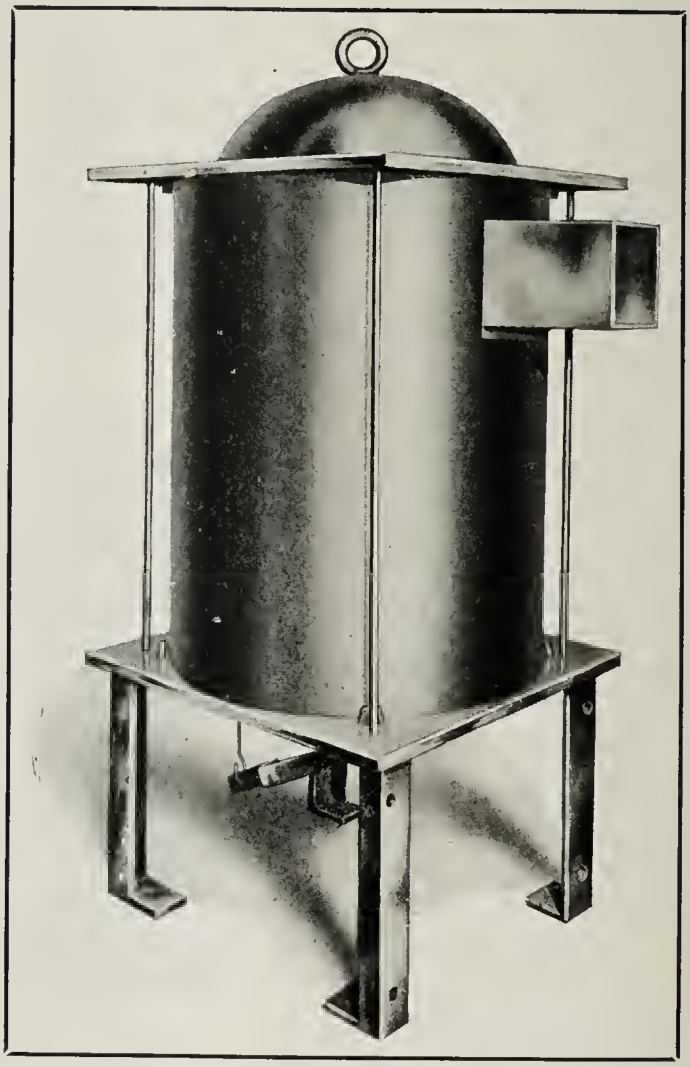
The "Woodison" Flask Clamp

Entirely eliminates the old style clamp with the wooden wedge. Can be used on any type of mold. Easily adjusted and practically unbreakable. Saves time and money. Price reasonable. Write for further details.

Woodison "Quality" Wax Vent

Made without string to hold it up, it leaves a perfectly clear vent. This wax is absolutely uniform at all times, easily handled and accurate. We ship it promptly wound on handy-sized spools. Price on application.

The Woodison Brass Furnace



enables you to get from 33⅓% to 50% greater melting capacity from the same amount of fuel. This is accomplished by properly arranging our area of flue and grate openings with relation to our combustion chamber.

These furnaces are made in several sizes and may be arranged for either a "solid cast" drop-grate, a "draw-bar" drop-grate or a "fixed" draw bar grate.

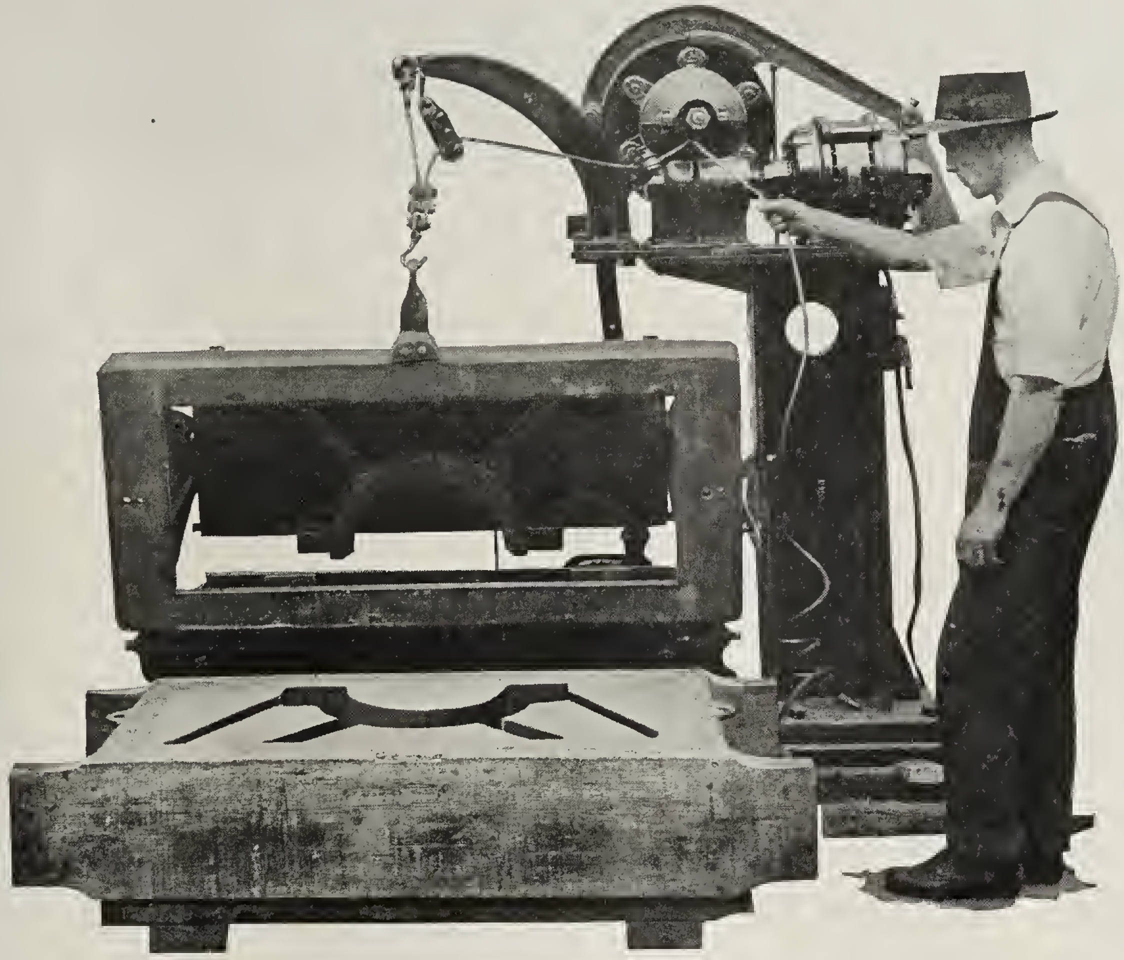
The elements of economy, efficiency, and safety are highly developed in the Woodison Brass Furnace.

Further details promptly furnished.

Write at Once!

The E. J. WOODISON COMPANY, Detroit

Boston Buffalo Cleveland Indianapolis St. Louis Seattle Montreal, Que. Toronto Windsor, Ont.



ANY HANDY-MAN CAN OPERATE

The Morrison Electric Jolt and Roll-Over Machine

"Made in the House that WOODISON built"

It doesn't need a mechanic to operate this machine, just take one of your handy men and he'll do it as well as an expert.

The Morrison is an all-electric jolt, ram and roll-over machine. It is the most up-to-date and efficient molding machine on the market today.

The dominant feature of our machine is a device that may be set so that the necessary number of jolts may be given a required job and no more. For example with a little experimenting a certain job may need 20 blows. The pattern on its return to the vault can be marked "20" and each time it comes to the machine, the operator will set the hand on the dial of the timer at the 20 mark.

The jolt mechanism is worked from a cam-wheel and the blows received on four steel anvils.

The roll-over device is operated by means of a cable from a crane arm. This cable is wound around a drum on the cam wheel shaft.

The pattern is easily drawn by means of a socket wrench and no levelling device is necessary. The above cut shows pattern drawn and table rolling back.

All wearing parts are made of the best-known materials, easily replaced and the up-keep is nominal.

The Morrison will take a flask up to 20½ x 40".

Write us for price and details or come to our plant for a demonstration, and bring your molding problems for us to solve.

The E. J. WOODISON COMPANY, Detroit

Boston Buffalo Cleveland Indianapolis St. Louis Seattle Montreal, Que. Toronto Windsor, Ont.

The Hill-Brunner Foundry Supply Co.

Yuletide Greetings

A Merry, Merry Christmas to Everybody
and
A Most Prosperous New Year awaits the Users of H-B Foundry Facings.

Your desire for castings with smooth sharp edges, well defined lines and uniformity of color will be attained if you use **H-B Foundry Facings.**

H-B Facings have been in daily use in the important Foundries of this country for over thirty years.

Here are our leaders:

No. 208 Plumbago
Hill's Black Core Compound
Partwell Parting
Favorite Core Wash
Sea Coal Facing
Red and Yellow Talc

Write for samples.

We also handle a complete line of Foundry Supplies and Equipment.

Let us know your requirements.

CINCINNATI, OHIO.
BIRMINGHAM, ALA.

KORDEK

FOOD CONSERVATION

The annual consumption of wheat flour by the foundries is very large. The governmental authorities are urging the conservation of wheat products, especially flour, in all directions. The conservation of wheat for food purposes is of vital importance in our present crisis. Every industry should co-operate with the Food authorities in the conservation of food. It is not at all unlikely that in the near future the use of wheat flour in all industries will be entirely prohibited.

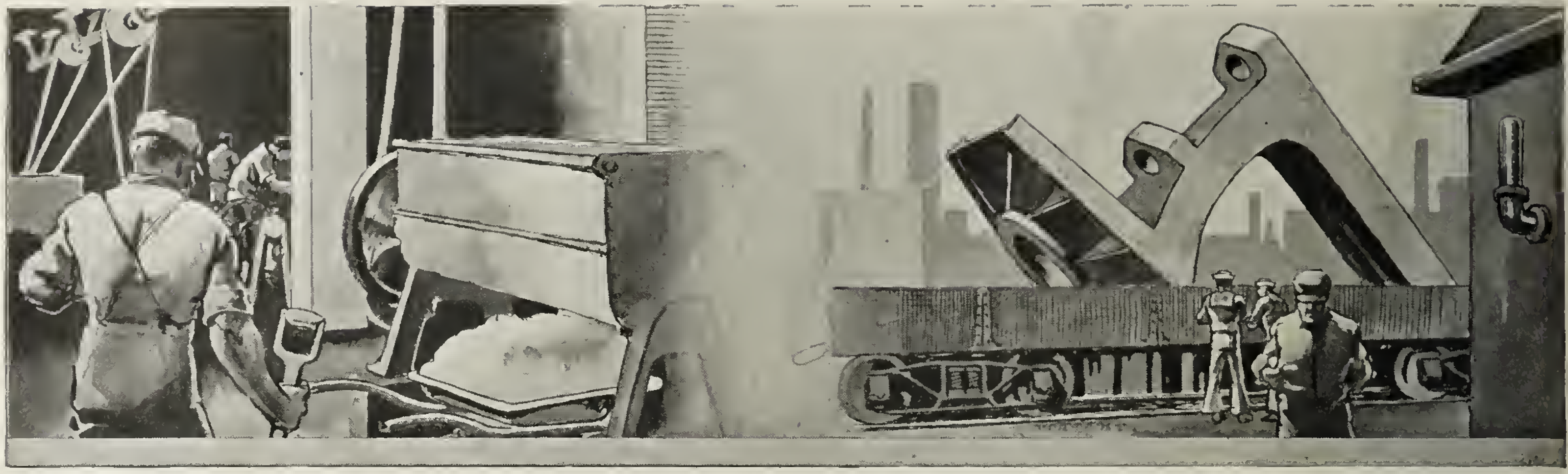
As many foundries are using flour both for the production and pasting of cores, the probability of such interdiction is of great importance to plants employing this valuable food product.

To prepare for such a contingency, all foundrymen who now use flour, should lose no time in testing out and adopting the most efficient and economical material in place of the same. To this end we earnestly recommend KORDEK for your serious consideration. KORDEK according to the tests which have been made is not only a better bond, but more economical than flour. As a paste for pasting cores KORDEK possesses greater strength and may be used without any inconvenience or trouble. KORDEK is a dry powder, like flour, and may be handled in all respects in a similar manner.

We should like you to convince yourself of the many superior qualities of KORDEK and will gladly provide a sample for the test.

CORN PRODUCTS REFINING CO.
17 Battery Place New York, N. Y.

KORDEK



Core - Mixing

The Finished Casting—for a U. S. Dreadnaught

Making a Perfect Casting

It is the finished casting that counts. If it is perfect it means a profit—a matter of satisfaction to the executive, to the superintendent and to the workmen themselves. If it is imperfect the whole day's work is lost.

But, back of a perfect casting lies the important "core". The ***perfect*** core produces the perfect casting.

Core making is dependent upon three factors—the binder, the sand and the man who decides on the mixture. (The two latter problems must be solved by the foundry itself.)

An ideal core-binder has eleven essentials. A scientific oil preparation has been produced to meet them all. This product has been serving America's leading foundries for more than eleven years. At the present time, 98% of its original users still place their faith in its use.

CORUL

(Formerly designated as Century XXX Core Oil)

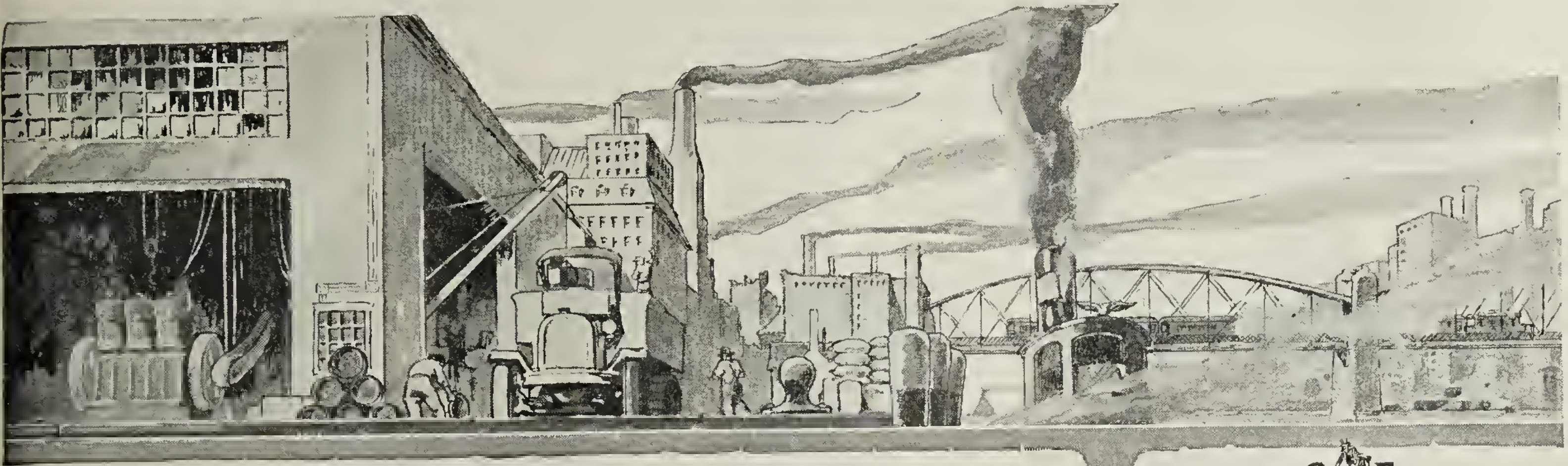
Corul has been developed by the Swan & Finch Engineering Department to a point where it is both the efficient and economical core binder for all classes of malleable and grey iron castings. It is of highest grade to meet the most exacting conditions —yet so economical as to justify its use in all grades of work.

Corul has the confidence of the industry, and you too, will be convinced of its merits if you will put it to a practical test.

We would appreciate the opportunity of sending a suitable amount for this purpose. Kindly indicate the quantity you desire.

The requirements of a core binder as well as other interesting data are fully described in "The Eleven Things You Want"—a booklet every foundryman should have. It will be sent free on request.

SWAN AND FINCH
COMPANY
NEW YORK
Quality Oil and Grease Products Since 1853



Whether a Machine is Worth $20 or $20,000—*Protect It*

The greatest factor in machinery depreciation—sometimes total loss—is carelessness: For instance—carelessness in not spending a few short hours finding out the scientifically correct lubricant for each part of each machine.

Why not impress upon the operator responsible for your machinery this fact—that it is false economy to consider the cost of lubrication on cents per pound for oil or grease, when—it should be based on the saving of dollars per unit of expensive machinery replacement.

The mechanics and plant superintendents of America are the highest class men of their kind in the world. They know their own machinery—they are anxious to get the most out of it; but grease and oil are comparatively small items in plant purchasing; in these busy times one is not apt to figure them in terms of machinery depreciation, H. P. delivered, coal pile consumed, and production capacity.

A Cup Grease, for Instance, to Protect Machinery—Must

—act quickly—withstand excessive bearing pressure—spread quickly—adhere to bearing surfaces—be tenuous and elastic—be ***all*** lubricant—absolutely prevent metal to metal contact—and must ***not*** liquefy or evaporate under intense heat—not cake at low temperature—not clog bearings or leave residue in cups.

CUPESE

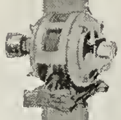
To meet these qualifications necessary to an ideal machinery protectant, the Swan & Finch Engineering Department has produced Cupese, a special quality of cup grease for various purposes—manufactured of special crudes by the exclusive Acaloric Process, which is a development of 64 years of scientific grease production.

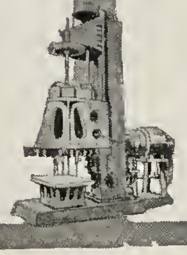
To any one interested in machinery and its operation, an engineering booklet—"Pennies Per Pound for Grease—or Dollars Per Year for Machinery Replacement," will be sent on request. Also specific information and samples of any Swan & Finch special grease and oil products.

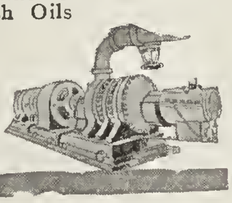
To Factory, mill and railway supply—hardware, oil and automobile accessory jobbers and dealers:

An unusual opportunity is open in some territories for a permanent, profitable distributing connection for the world-known S-F Atlas Grease and Oil Specialties, selling to mills, manufacturing and other industrial plants, railways, and auto accessory and hardware distributors. Write for prices, plans and territorial arrangements.

SWAN AND FINCH COMPANY
NEW YORK
Quality Oil and Grease Products Since 1853







S F ATLAS LUBRICANTS

Specialties :

SLO-FLO
The super-lubricant—will not drip, climb nor spatter—withstands excessive heat and pressure.

CORUL
A liquid binder that meets the 11 requirements of perfect core casting.

TALESE
An economical, practical drop-forge die-swabbing grease compound.

CUPESE
A quality cup grease for all machinery requirements.

TEXTUL
An economical, high quality oil compound for wool and worsted manufacture.

AERUL
A practical high quality oil for aeroplane motors.

MOTUL
A superior quality motor oil for the protection of valuable automobiles.

GEARESE
A correct transmission and differential lubricant for motor cars and trucks.

MARINUL
A world-known special oil, produced to meet the excessive stresses of marine service.

ASBESTESE
An asbestos and wool-mixed grease lubricant for car journals.

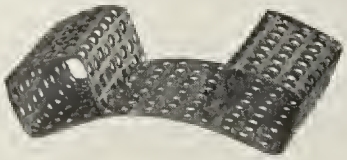
EXESE
The 600° F. Lubricant—for oven gears, bloom cars, calender rolls, automatic stokers or lubrication under excessive heat conditions anywhere.

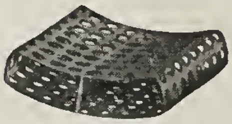
VESUVESE
A waterproof lubricant for exposed gears—for cable dressing.

LARCUL
A practical, economical metal-cutting lubricant.

ATLAS GENERAL LUBRICANTS
Atlas Engine Oils
Atlas Cylinder Oils
Atlas Turbine Oils
Atlas Dynamo and Motor Oils
Atlas Crank Case Oils
Atlas Transformer Oils
Atlas Cutting Oils
Atlas Tempering and Quenching Oils
Atlas Spindle and Loom Oils
Atlas Wool Oils
Atlas Leather Oils and Greases
Atlas Fish Oils

FEDERAL: Perfected Perforated Tin Chaplets


Style 4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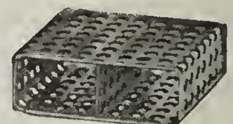
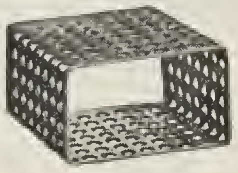
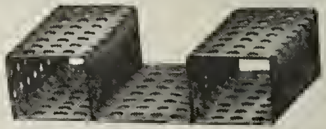
Style 6


Style 2


Style 1

Style 7

Style 8


Style 3

Practically indispensable for small castings.

Federal perforated chaplets are absolutely true to size.

They unite perfectly with the melted metal.

They make an absolutely pressure tight joint.

Made to your specifications at once and delivered promptly.

Tell us style you want and say what thickness, width and length. For Chaplets 4, 5, 6 and 7 state core diameter.

FEDERAL

The Vent Wax that works with all core binders

Accuracy and economy demand Federal Vent Wax.

Vents are always full size of the wax.

Coils don't cling to each other and go wrong.

Bends easy but is hard enough to stay in shape.

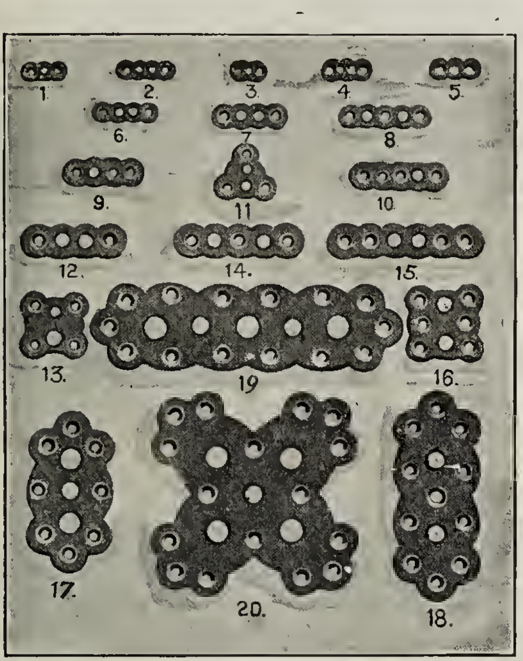
Actually improves the core stock.

The Federal Foundry Supply Co.

CLEVELAND, O.

Branches: San Francisco, Seattle, Milwaukee

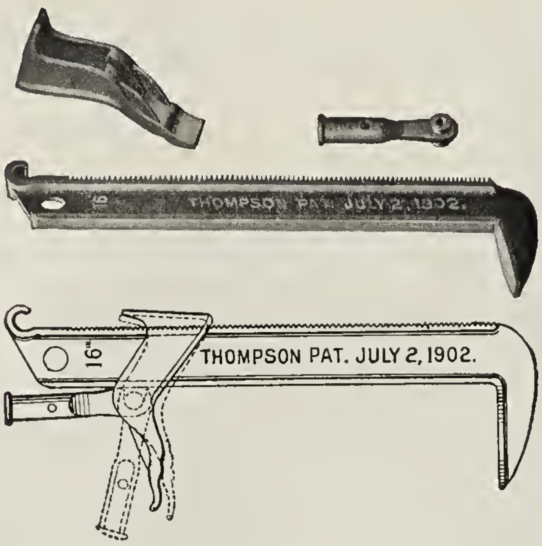
Obermayer Rapping Plates and Lifters



Our Rapping Plates and Lifters are the best made from Malleable Iron. Smooth, true, straight, accurately machined and tapped.

Complete stock in all our Warehouses

Thompson's Patent Adjustable Malleable Iron Flask Clamps



Seven Sizes—10 to 42 inches
Practically Indestructible

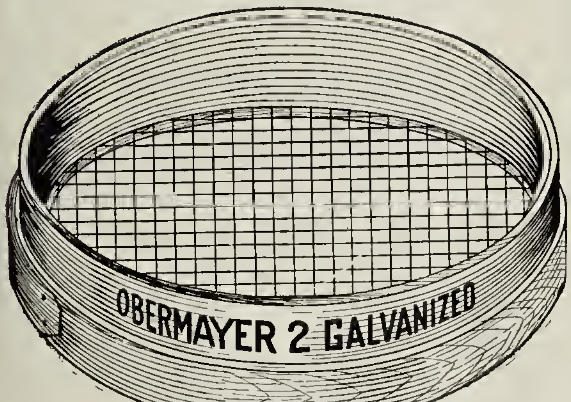
Cost no more than the ordinary kind.

Complete stock in all our Warehouses

OBERMAYER

OBERMAYER

"Esso" Quality Foundry Riddles



The strongest, heaviest and best made Riddles on the market.

Rock Elm Rims

Full Specifications Furnished on Request

Made in Heavy Galvanized and Brass—16", 18", 20", 21", 22" diameter.

Complete stock in all our Warehouses

Obermayer National Iron Filler Cement

Repair Defective Castings with National Iron Filler Cement

With a can of this cement handy there is no use scrapping castings because of blowholes, cracks and other unsightly defects. It's a very easy matter to repair such blemishes by simply mixing a quantity of National Iron Filler Cement with a little water and applying this with a knife.

The cement settles in a few hours and becomes as hard as the iron itself, and you cannot tell that the casting has been repaired. In 12-lb. Tin Cans and 100-lb. kegs. Free Samples on application.

Stock in all our Warehouses

The S. Obermayer Co.

Manufactures Everything You Need in Your Foundry

Chicago Cincinnati Pittsburg St. Louis Denver Los Angeles

Always reliable

VULCAN BLACKING

AJAX BLACKING

Mica Facing
for
Green Sand Work

Order a barrel on approval.

Write for catalog No. 30 A of McCormick Products.

J. S. McCormick Co.
Foundry Supply Depot
Pittsburgh ∴ ∴ Pa.

Core Room Equipment

Wadsworth All Steel Core Trays

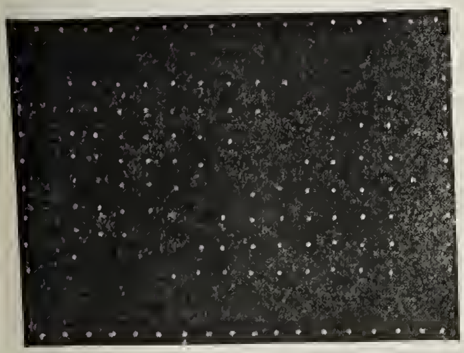
Strongly reinforced.
Perfectly straight.
More economical.
Crooked Cores eliminated.
1-3 the weight of Cast Iron.
Trouble prevented.
Efficiency promoted.
Profits greater.
Standard sizes.
Special size made to order.

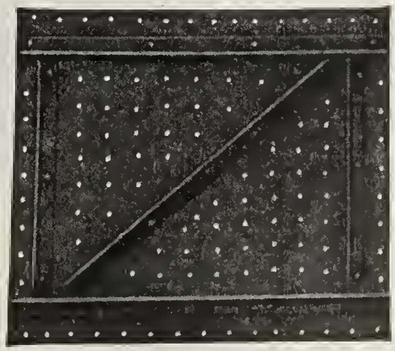
Never break and never burn

WADSWORTH QUALITY

Wadsworth All Steel Bottom Plates

Made from steel, practically unbreakable and can not be destroyed by burning. They are made perfectly straight, and weigh but a third as much as cast iron plates. These WADSWORTH Reinforced Snap Flask Mold Base Plates will greatly assist you in improving the quality of your work and in cutting down your expenses. Full details sent upon application. Standard sizes listed below. Special sizes made upon order.





Regular sizes for Core Trays and Bottom Plates:

9" x 12"
9" x 15"
9" x 18"
12" x 9"
12" x 12"
12" x 15"
12" x 18"
12" x 20"
12" x 24"
15" x 9"
15" x 12"
15" x 15"
15" x 18"
15" x 20"
15" x 24"
18" x 9"
18" x 12"
18" x 15"
18" x 18"
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20" x 18"
20" x 20"
20" x 24"
24" x 12"
24" x 15"
24" x 18"
24" x 20"
24" x 24"

Never break and never burn

THE WADSWORTH CORE MACHINE & EQUIPMENT CO.
AKRON, OHIO, U. S. A.

BLOOMSBURY
Special Plumbago

THIS is a mixture of Ceylon leads; specially adapted to general foundry work. It can be dusted, brushed or slicked on mold with uniformly good results.

You will find it wonderful value at our direct prices.

Samples free in any amount required for a fair trial.

BLOOMSBURY
FOUNDRY FACINGS

DIRECT
FROM MILLS
TO YOU

Graphites
Silver Lead
Plumbago
Blackings
Core Wash

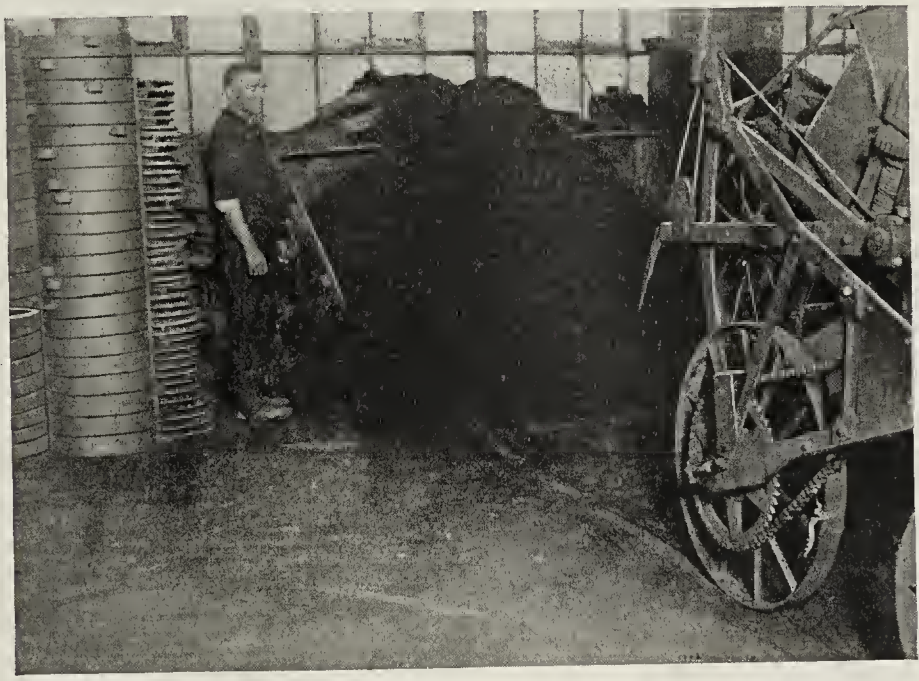
Pipe Blackings
Mineral Facing
Stoveplate Facings
Charcoal Facings
Sea-Coal Facing

BLOOMSBURY GRAPHITE MILLS
Bloomsbury, N. J. Established 1882

A Man Remarked:

"Yes, indeed, I have known your sand cutting machine for years. An excellent thing, especially in stove shops; but *we* work differently, you know. Our men are all on molding machines, and need their sand piled right alongside the machines, within reach".

Here is the answer:

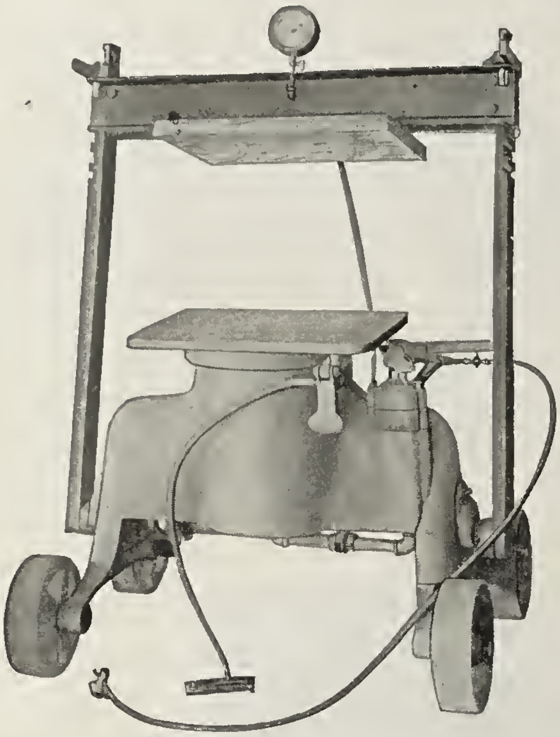


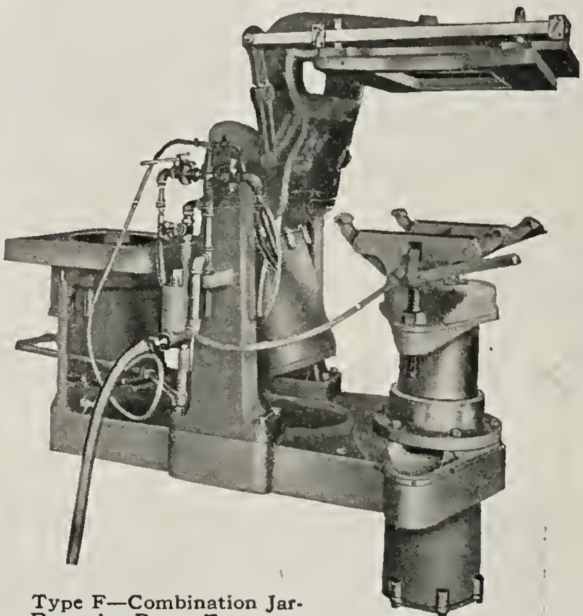
The Auto Sand Cutter cuts this great heap of sand to a superfine texture, and *drifts it into a pile,* at the rate of 6 to 8 double floors per hour. Smaller floors in proportionately less time. If valuable for floor molding, it is *doubly* so for *stationary bench and machine molding.*

Also mixes core and facing sand satisfactorily.

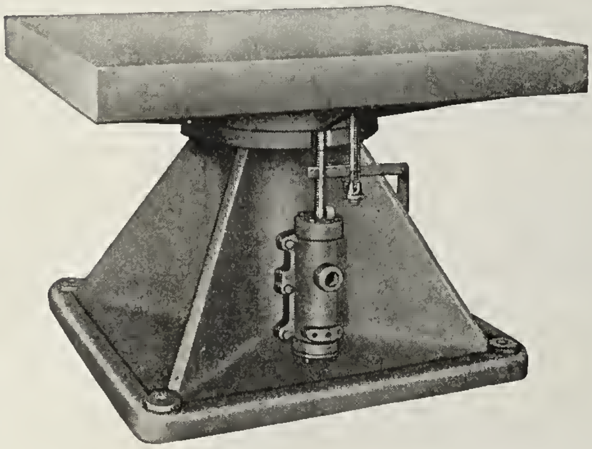
What would such service be worth to you?

THE SAND MIXING MACHINE COMPANY., Inc.
AMERICAN FOUNDRY EQUIPMENT COMPANY
52 Vanderbilt Avenue, New York City
Factory: Cleveland, Ohio

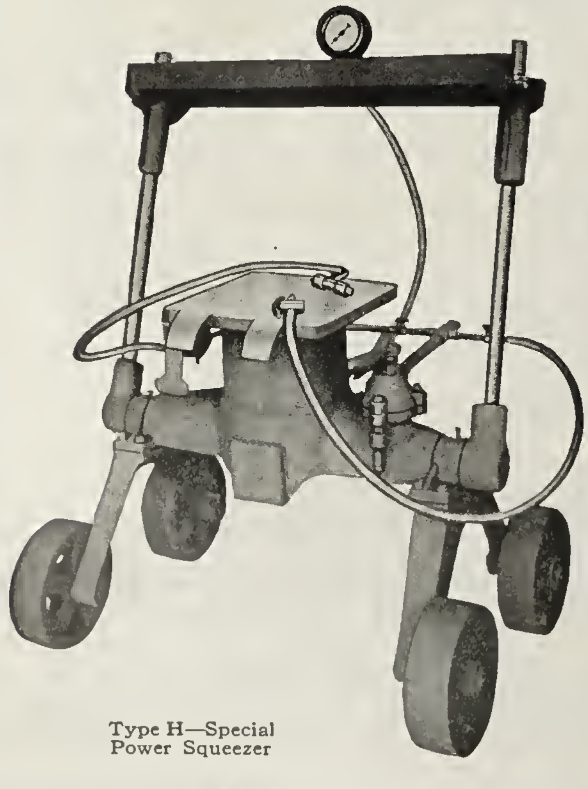

Type H—Power Squeezer

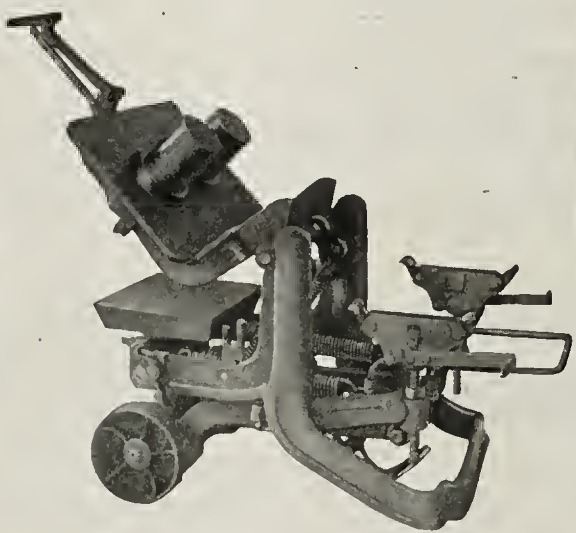

Type F—Combination Jar-Ramming Power Turn-over Power Draft Machine

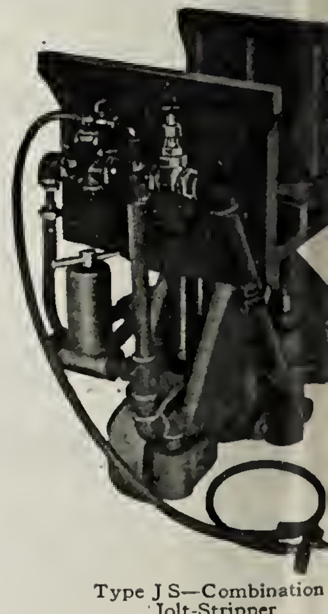
Type A—Power Turn-over Power Draft Machin

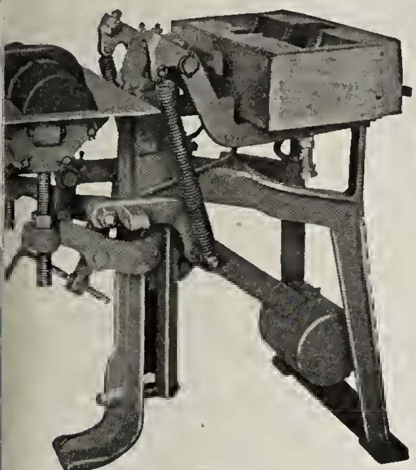

Type J—Air Jarring Machine

ALL types of INTERNATIONAL machines are built with the same degree of mechanical excellence that will be found in the highest grade of machine tools. The adjustments, although simple and rapidly made, insure the application of each machine to an unusually wide range of work. A large measure of reserve strength, revealed in both design and material, eliminates the possibility of breakages even under the severest strain and roughest usage. A variety of styles so vast as to embody every practical principle of ramming and pattern drawing enables us to offer the one **best** machine for the work to be made. Our No. 14 Catalog illustrates and describes all standard designs.


Type H—Special Power Squeezer


Type M—Combination Jar Ramming Turn-over Draw Machine


Type J S—Combination Jolt-Stripper



Type R—Special Core Turn-over Machine

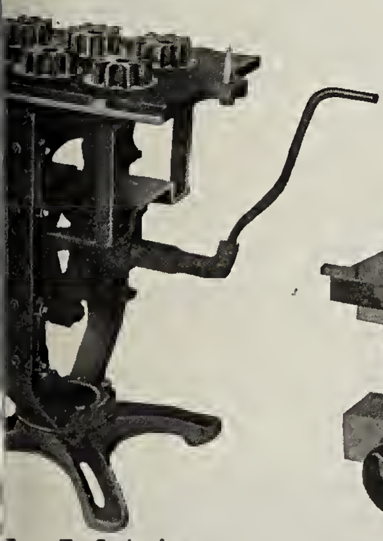
Type J—Special Core Jarring Machine

Type C—Combination Stripping-Squeezer

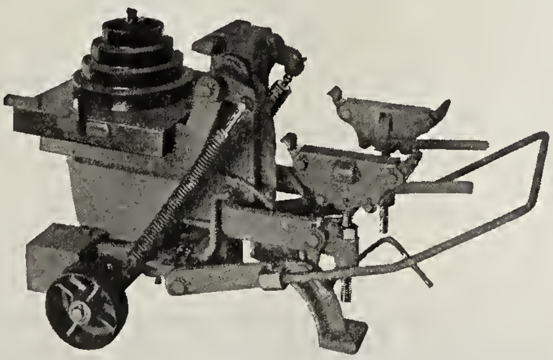
THE most careful judgment is exercised by the manufacturers of high class products in the selection of the equipment for their foundries because they know that the operations of this department are reflected in all departments in which the castings are subsequently handled. INTERNATIONAL machines enter extensively into the manufacture of **Cadillac, Packard** and **Marmon** Cars,—**Crane** and **Lunkenheimer** Valves,—**B. & S.** Tools, **I H C** Implements and countless other universally known products.

INTERNATIONAL MOLDING MACHINE CO.
2614-2618 West Sixteenth Street, CHICAGO, ILL.

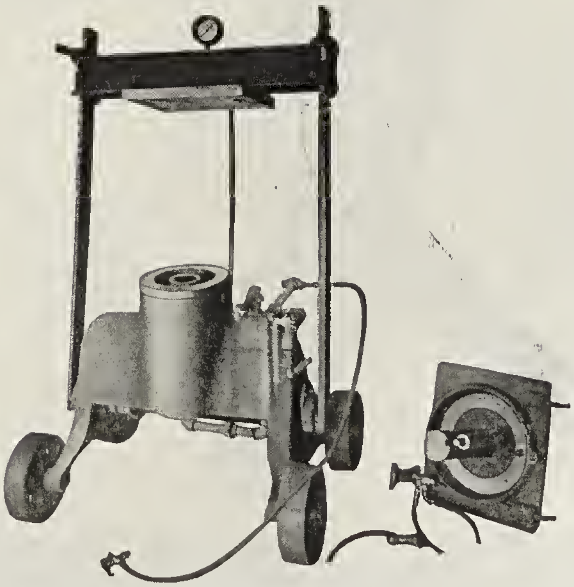
Type B—Electric Jarring Machine



Type T—Stripping Plate Machine



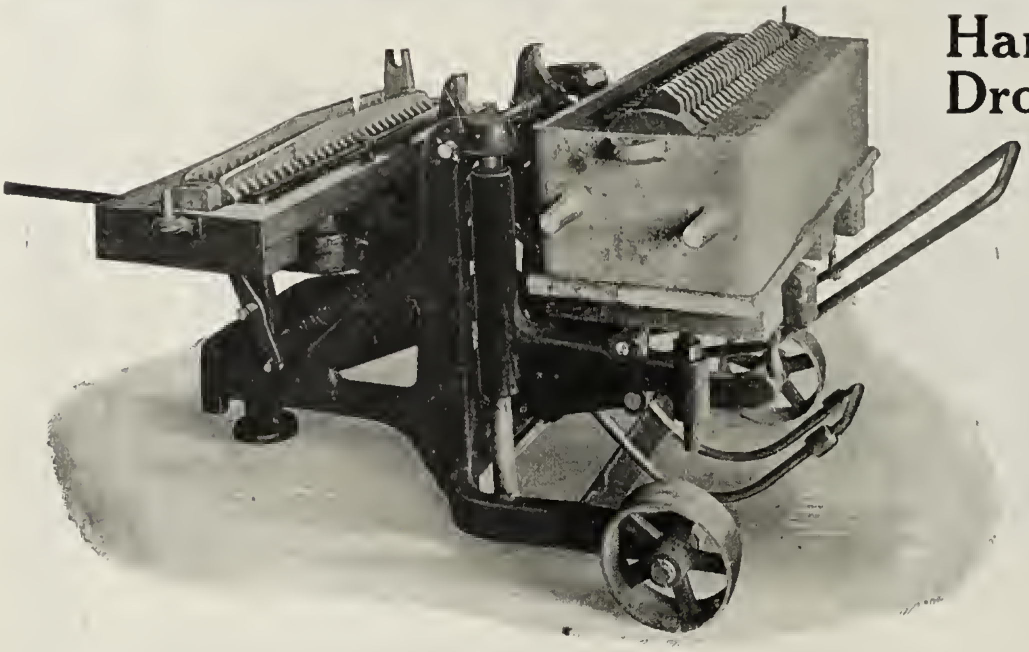
Type R—Turn-over Draw Machine



Type JS—Combination Jolt-Squeezer

Pridmore

Strong Argumen

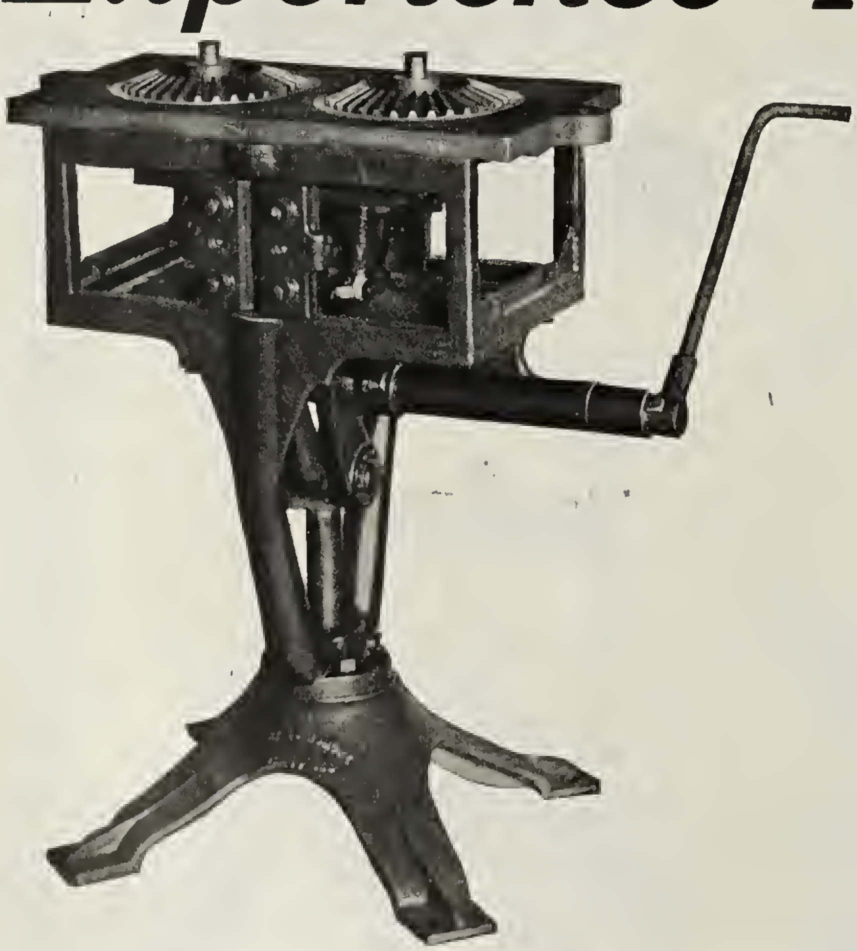


Hand Rock-Over Drop Molding Machine

There is no need to go into details regarding the construction of this machine. You know that if it is the "Pridmore" that it is built right and is strictly up to date. We just wish to use this space to remind you of what it is doing for others.

The illustration shows a 22"x18"-8" Drop Machine fitted with a 36" Furnace Grate. With this machine two men made sixty molds in 6½ hours of actual molding time—practically doubling the output as compared to the former hand molding methods.

Experience Plus Scienc



Hand Stripping Plate Molding Machine

The "Pridmore" line of machines of this type is complete, embracing eight regular and eight special types in more than five hundred and fifty sizes.

Today fully 95% of all the Stripping Plate Machines used throughout the world are "Pridmores."

You can depend upon every "Pridmore" machine you buy. All are designed to give the maximum output with minimum labor—and have the construction to do so for years without interruption.

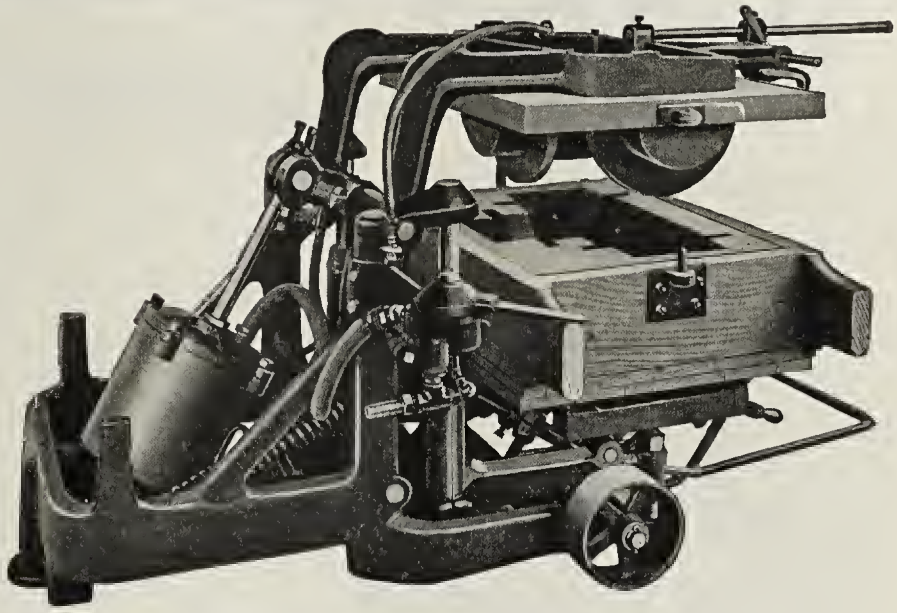
HENRY E. PRIDMORE 19th and ROCKWELL STREETS
CHICAGO, ILL.

Foreign Representative: J. W. JACKMAN & COMPANY, LIMITED, Show Rooms and Works, VULCAN WORKS, Blackfriars Road Manchester, England. Head Office, CAXTON HOUSE, Westminster, London, S. W.

Strongly Backed

Pridmore

Air Power Rock-Over Drop Molding Machine

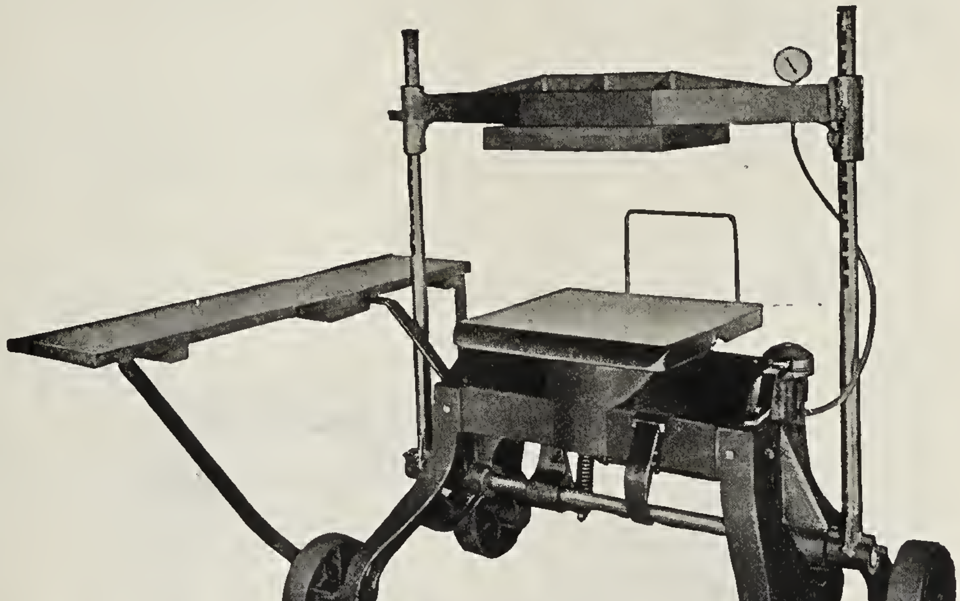


The illustration shows our well known ROCK-OVER DROP Machine to which we have added Pneumatic Power, thereby increasing its rolling over capacity. It is made in one size, 29"x24", with 8" and 12" drop.

A well known Automobile Concern is using ten of these machines.

Insures Highest Quality

Air Power Squeezer Machine



Here's a labor-saving, time-saving, output-increasing machine that it will pay you well to employ in your foundry.

No expert labor required to operate this machine.

The operation is extremely simple —involving few "moves."

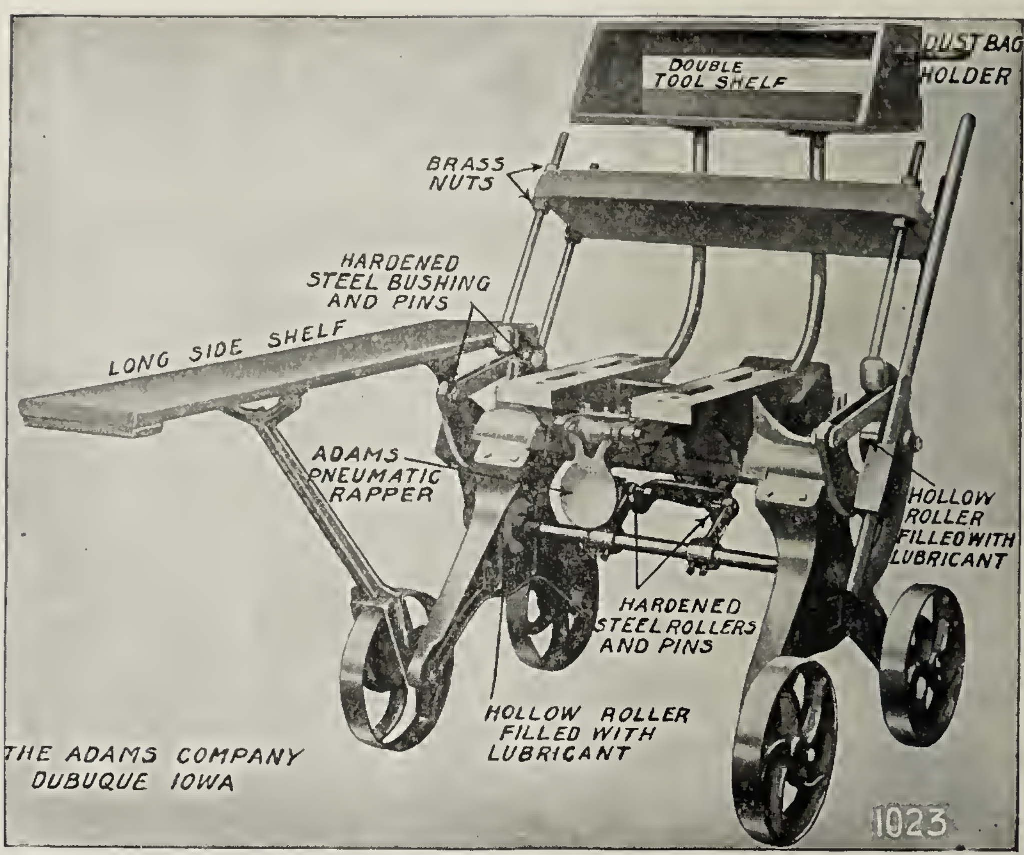
All control parts are conveniently located.

The mold is rammed in a fraction of the time required for hand molding. The production of the "Pridmore" Power Squeezer is 25% greater than any other squeezer on the market

HENRY E. PRIDMORE 19th and ROCKWELL STREETS
CHICAGO, ILL.

Foreign Representative: J. W. JACKMAN & COMPANY, LIMITED, Show Rooms and Works, VULCAN WORKS, Blackfriars Road
Manchester, England. Head Office, CAXTON HOUSE, Westminster, London, S. W.

I WANT A JOB


DOUBLE TOOL SHELF
DUST BAG HOLDER
BRASS NUTS
HARDENED STEEL BUSHING AND PINS
LONG SIDE SHELF
ADAMS PNEUMATIC RAPPER
HOLLOW ROLLER FILLED WITH LUBRICANT
HARDENED STEEL ROLLERS AND PINS
HOLLOW ROLLER FILLED WITH LUBRICANT
THE ADAMS COMPANY DUBUQUE IOWA
1023

32-inch Adams-Farwell Portable Squeezer—the most popular Molding Machine ever produced.

Have you not an opening in your foundry for a molder's helper?

I have worked in many of the largest and most up-to-date foundries in the United States. I have helped to reduce the cost of castings, (in many cases 50%), and for nice, even, uniform castings there are none that can beat me.

The molders like my work, for I make it easy for them to put up a big floor. With my help the patterns can be changed with but little work on the molder's part.

The only hard part is the pouring of the iron. I must have a good flask to work with, and the one I like best is the Adams Cherry Snap Flask.

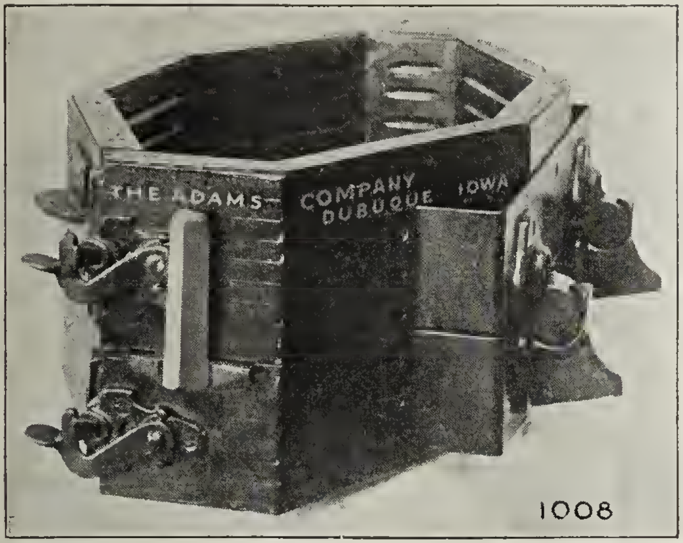
Chimey Cap—15" x 19" Flask, 8" Cope, 2½" Drag.

Give me a trial, and I will show you how to reduce the cost of your castings. I never fail.

(Signed) **Adams-Farwell Double Rod Molding Press**

P. S. For full particulars write

THE ADAMS COMPANY
DUBUQUE, IOWA, U. S. A.



An Octagon Shaped Flask, Fitted with Roll-up hinges. Long pins fitted for straight draw also.

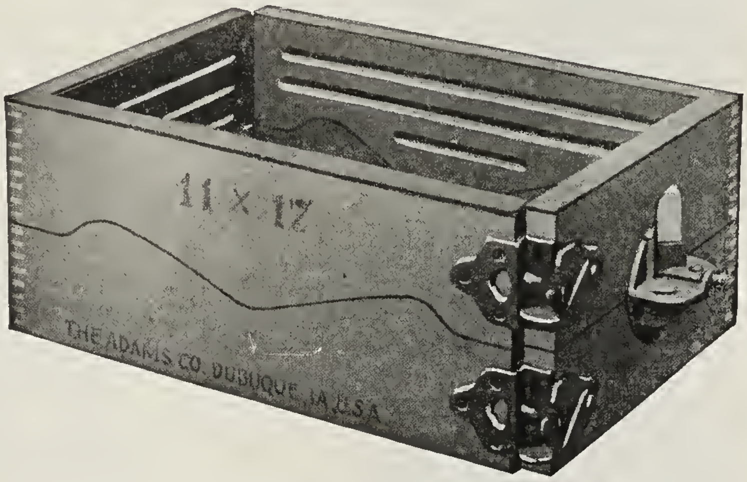
BETTER PRODUCTS

FASTER AND AT A LOWER COST

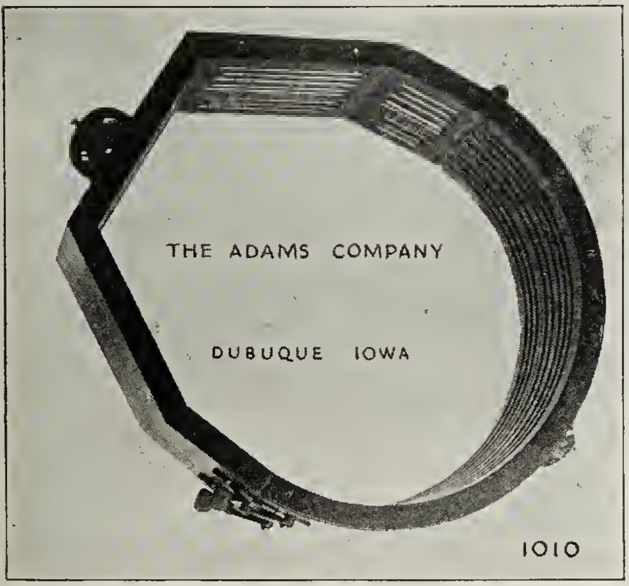
Everybody is anxious to increase production and decrease cost. There is no better way than to start with a good flask.

A good flask will not spring and make a shift in your castings. Your castings will be of a more uniform, even thickness.

The molders can put up larger floors. They have far less trouble in getting a good draw.



Irregular partings made to your templets or drawings.



Irregular Half-Round Flask. Saves handling unnecessary sand.

Adams Cherry Snap Flasks

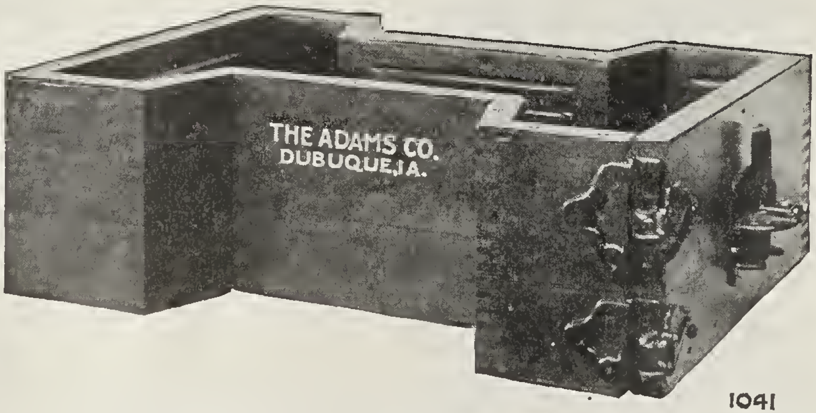
are especially well adapted for squeezer work.

They are made of 1⅛" selected, air-dried cherry lumber. Corners are machine locked and glued. Angle irons are screwed on top and bottom of flask. Pins and ears are milled and set at right angles to parting. Snaps are quick acting, and are made of malleable iron. Hinges are milled at bearing points, and they fit snugly and work easily.

For a good flask write

The Adams Company

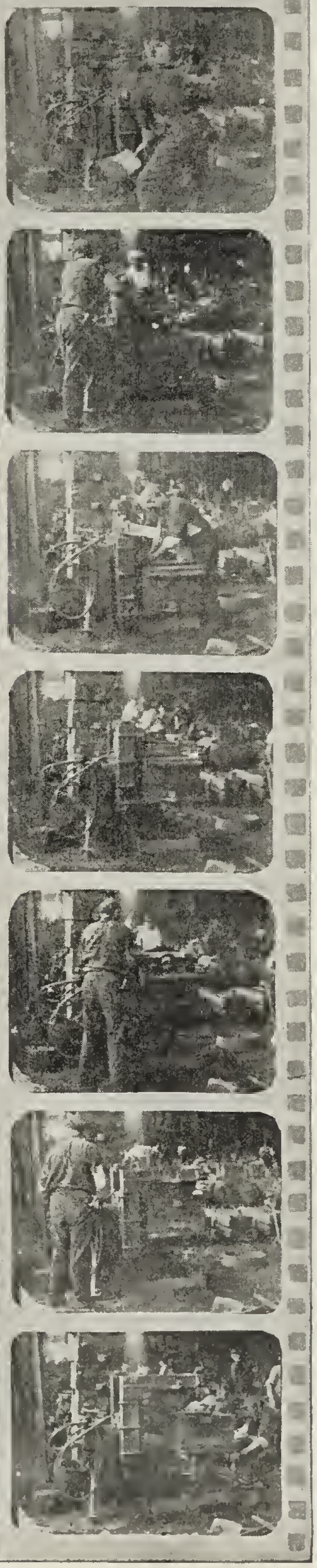
Dubuque, Iowa, U. S. A.



1041

Irregular shaped Flask. Saves handling a lot of sand.

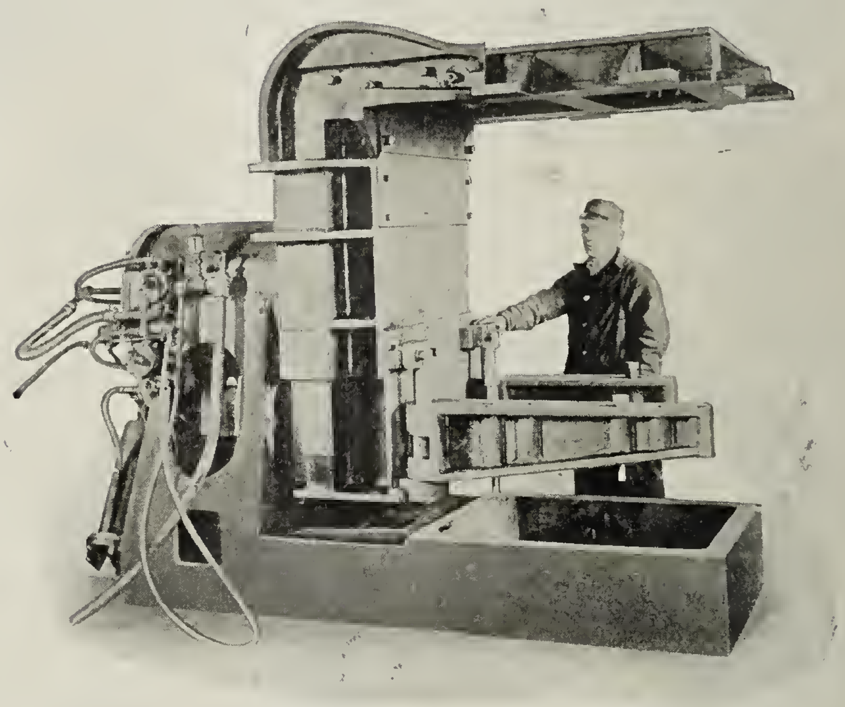
Grimes
Jolt-
Rammed
Rollover
Machine



GRIMES ROLLOVE

Speed up

Production

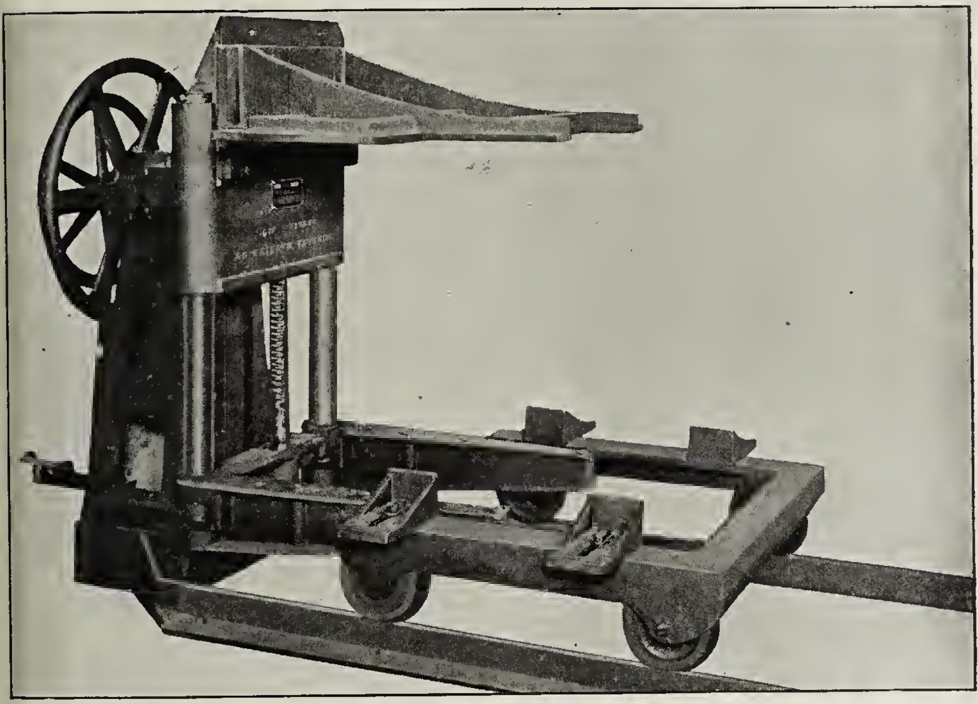


We have helped many foundrymen solve molding and labor problems

MOLDING MACHINES

on account of

Simplicity of Design
Ease of Operation
Small floor space required

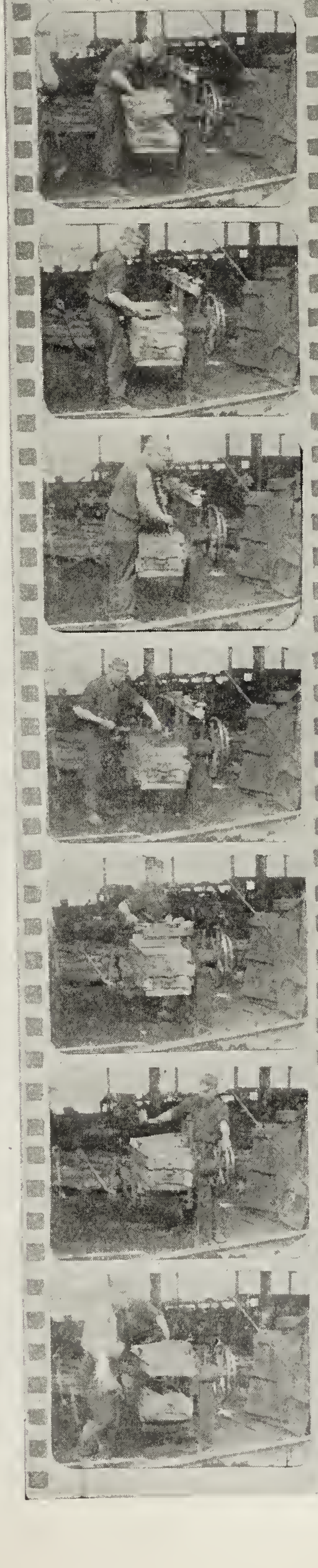


At your service

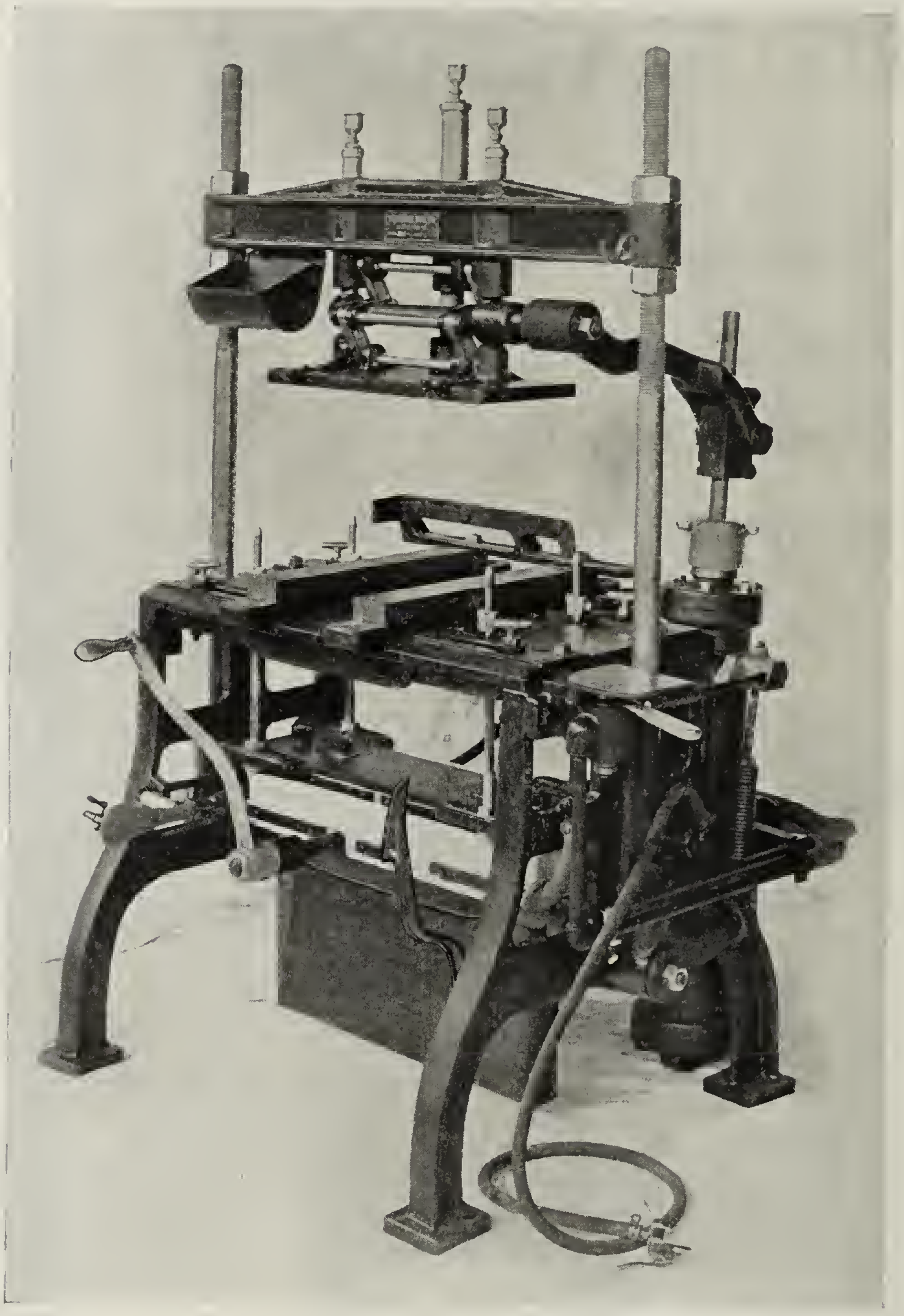
MIDLAND MACHINE CO.

11 West Jefferson Ave. DETROIT, MICH.

Grimes
Hand-
Rammed
Rollover
Machine



Berkshire Air Squeezers



WHY ?

Why has the United States Government equipped its Navy Yards, both east and west, with this Machine ?

Why have ten of the largest Automobile Companies in the world over four hundred of this model ?

Why have the very latest Malleable Iron Foundries equipped with BERKSHIRES ?

Why have the largest Brass Foundries and Builders of Special Appliances of the highest grade, equipped in some instances exclusively ?

Why is it you have not seen a BERKSHIRE Salesman for the past two years and are not likely to see one unless upon request ?

Because we sell all we can make without them, also because no other machine can produce with speed and quality of output equal to the BERKSHIRE.

The Berkshire Mfg. Co.

Cleveland, Ohio

BEFORE AND AFTER

FROM START TO FINISH the operation of the Mumford 10" High Trunnion Squeezer is continuous—fast—reliable—always under the direct control of the operator. From table to truck, before and after, work goes on without a hitch, molds true to pattern, air on and off at will.

The man at the throttle valve gets instant response. He can work 10% faster than with a low trunnion machine, and with 30% less effort than is necessary with hand squeezers.

Do YOU get service like that?

Write for details, prices, deliveries, etc.

Vulcan Engineering Sales Company
1759 Elston Avenue Chicago, U. S. A.

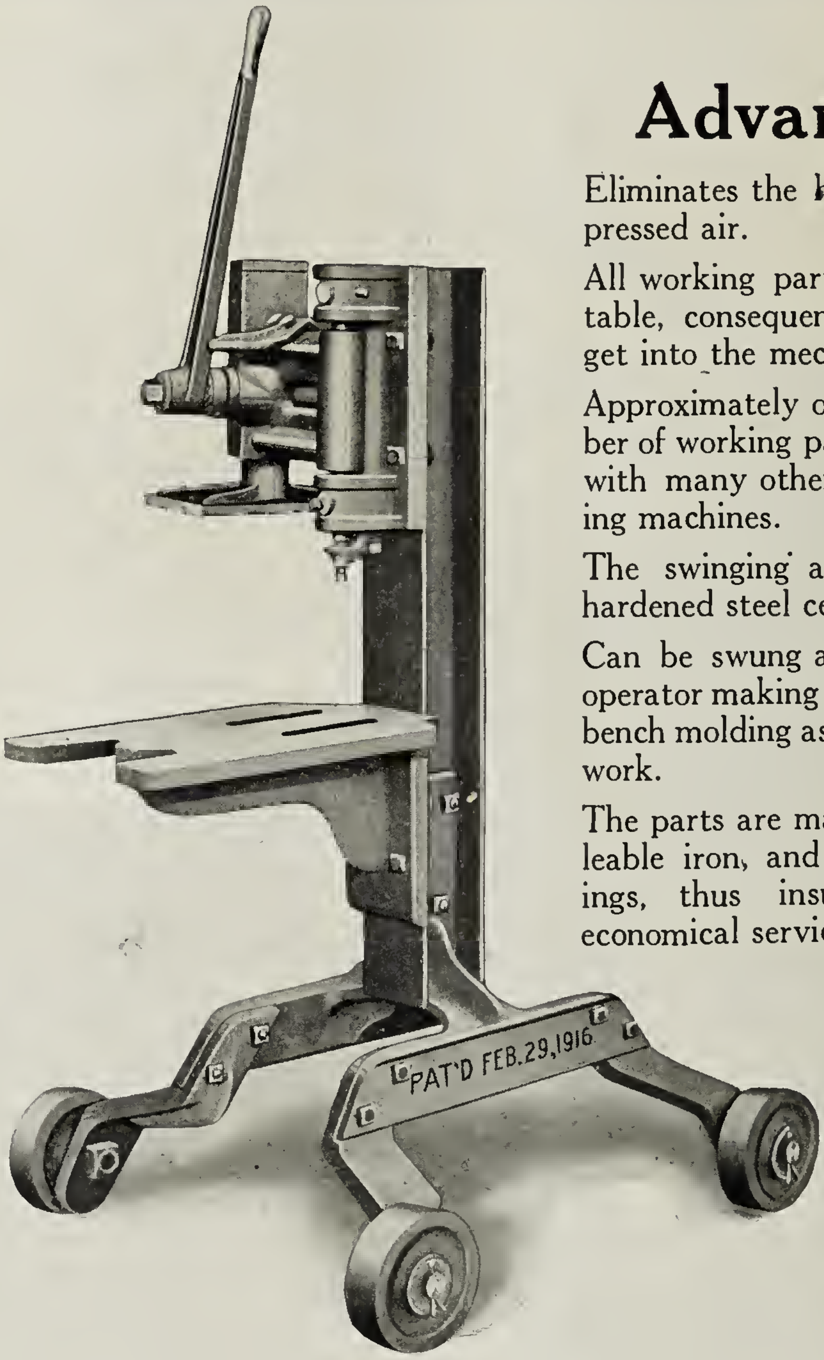
Sales Agent for
Hanna Engineering Works Mumford Molding Machine Company
The Q M S Co. J. C. Busch Co.

Foreign Agent
J. W. Jackman & Co., Ltd., Caxton House, London

Moline Machines Will Satisfy

Used and Endorsed by

Rock Island (U. S. A.) Arsenal, Rock Island, Ill.
Deere & Co., Moline, Ill.
Chicago Malleable Casting Co., Chicago, Ill.
American Steel & Wire Co., Cleveland, Ohio
Turner and Seymour Mfg. Co., Torrington, Conn.
Rock Island Plow Co., Rock Island, Ill.
Fairmount Foundry Co., Philadelphia, Pa.
Goulds Mfg. Co., Seneca Falls, N. Y.
Newton Kelsay Co., Evansville, Ind.
Union Malleable Iron Co., Moline, Ill.
Stewart-Warner Speedometer Corporation, Beloit, Wis.
University of Kansas, Lawrence, Kan.
Moline Plow Co., Moline, Ill.
Johnson Harvester Co., Batavia, N. Y.
North & Judd Mfg. Co., New Britain, Conn.
Burd High Compression Ring Co., Rockford, Ill.
O. B. North & Co., New Haven, Conn.
and hundreds of other large and progressive foundries.



Advantages

Eliminates the high cost of compressed air.

All working parts are above the table, consequently sand cannot get into the mechanism.

Approximately one-half the number of working parts as compared with many other types of molding machines.

The swinging arm balanced on hardened steel centers.

Can be swung at the will of the operator making it convenient for bench molding as well as squeezer work.

The parts are made of steel, malleable iron, and semi-steel castings, thus insuring long and economical service.

Can use flasks as large as 12"x24".

As many as 285 molds (10"x16" flasks) have been made in 7¾ hours.

No. 1 Molding Machine— Stationary type.

No. 2 Molding Machine— Portable type to run by the side of the sand pile.

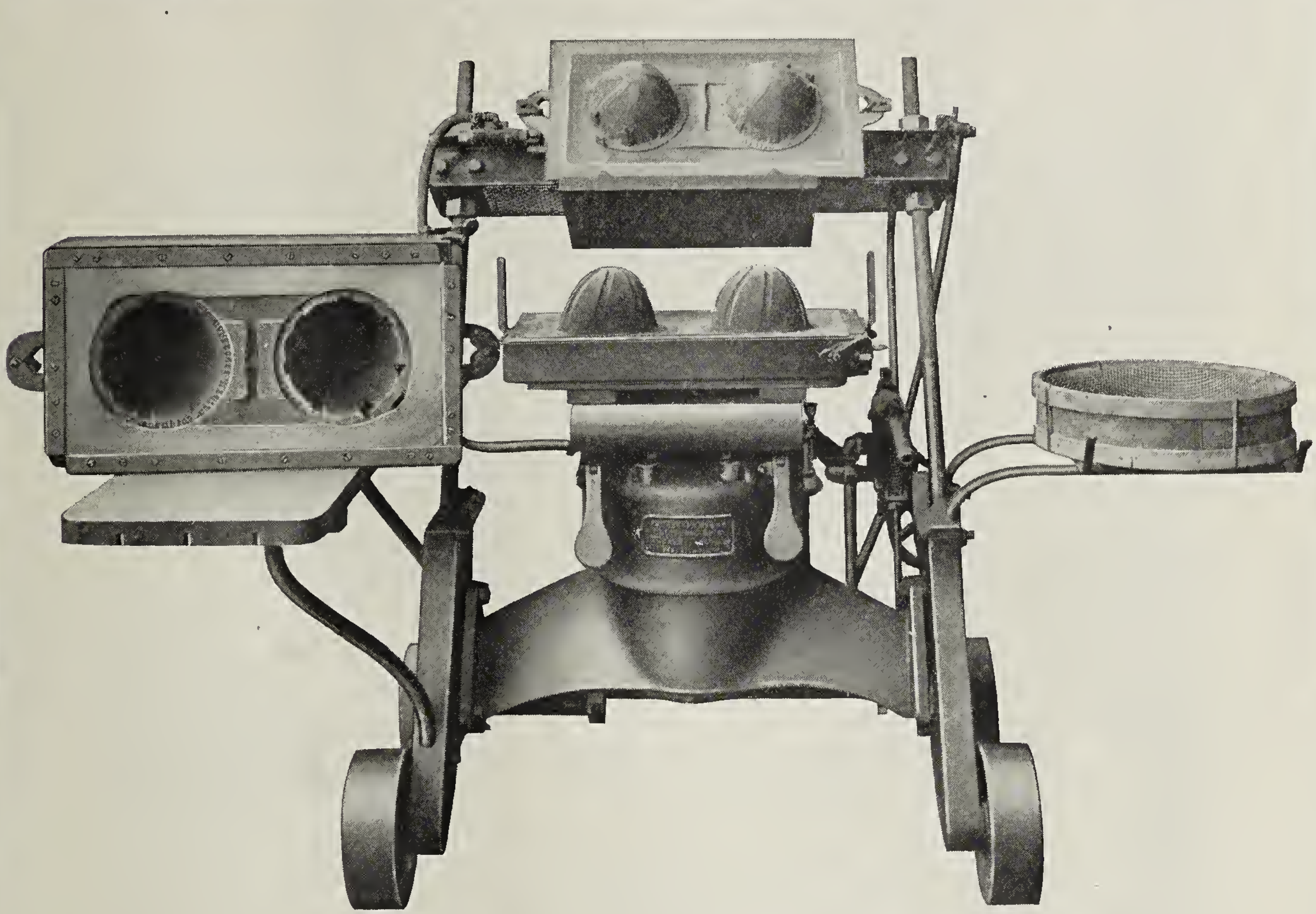
No. 3 Molding Machine— Portable type to run over the sand pile.

Write for full details and prices

H. W. Cooper Saddlery Hardware Mfg. Co.

Moline, Illinois
Department No. 6

OSBORN SQUEEZERS OSBORN



Accurate **Increase Your Production**

The OSBORN AIR SQUEEZERS are made to handle many classes of bench work. Made in several sizes to accommodate any work that is practical to make on a Squeezer Machine. ¶ Can be used either as a Jolt Machine or Plain Squeezer. Has ample foot room for the convenience of the operator. ¶ By the adjustment of the compression valve any desired pressure can be secured, all moulds being squeezed exactly alike, regardless of the pressure in the air line. ¶ If used for jolting, slight pressure of the knee valve does the work. Is always ready. Is a time saver. ¶ It is accurate, does more work in a given time and does it with far less exertion on the part of the operator. ¶ Suitable for many kinds of Foundries: Malleable—Grey Iron—Brass—Aluminum, etc.

Write for Catalog

THE OSBORN MANUFACTURING CO.

Brushes and Brooms—Foundry Supplies
Moulding Machines and Accessories

CLEVELAND
5401 Hamilton Avenue

New York
395 Broadway

Chicago
155 No. Clark Street

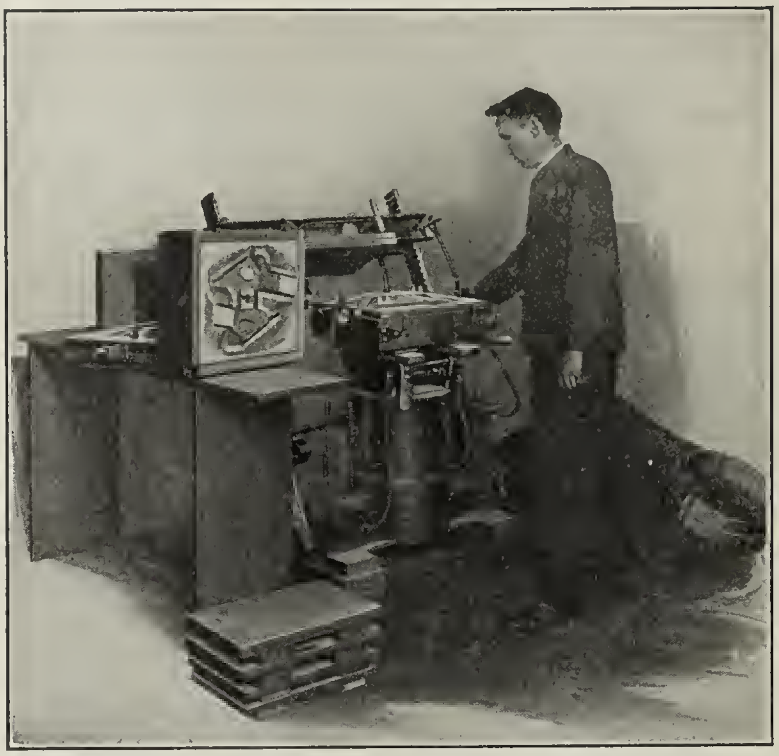
Milwaukee
259 So. Water Street

Detroit
94 McDougall Street

Boston
41 Pearl Street

San Francisco
61 First Street

TABOR



10" POWER SQUEEZER

We have had 92 of these machines operating in one shop for over nine years and the total cost of repair parts ordered has been less than $10.00 —a striking tribute to TABOR QUALITY.

There is No Faster Machine Made

The only mechanical operation of any plain squeezer is bringing up the head and squeezing the mold which requires but .06 minute on the Tabor—take your stop watch and verify this.

The choice of Squeezers is a matter of quality and workmanship and both are of the highest in the Tabor.

SEND FOR BULLETIN M-R

THE TABOR MANUFACTURING CO

PHILADELPHIA
PA.

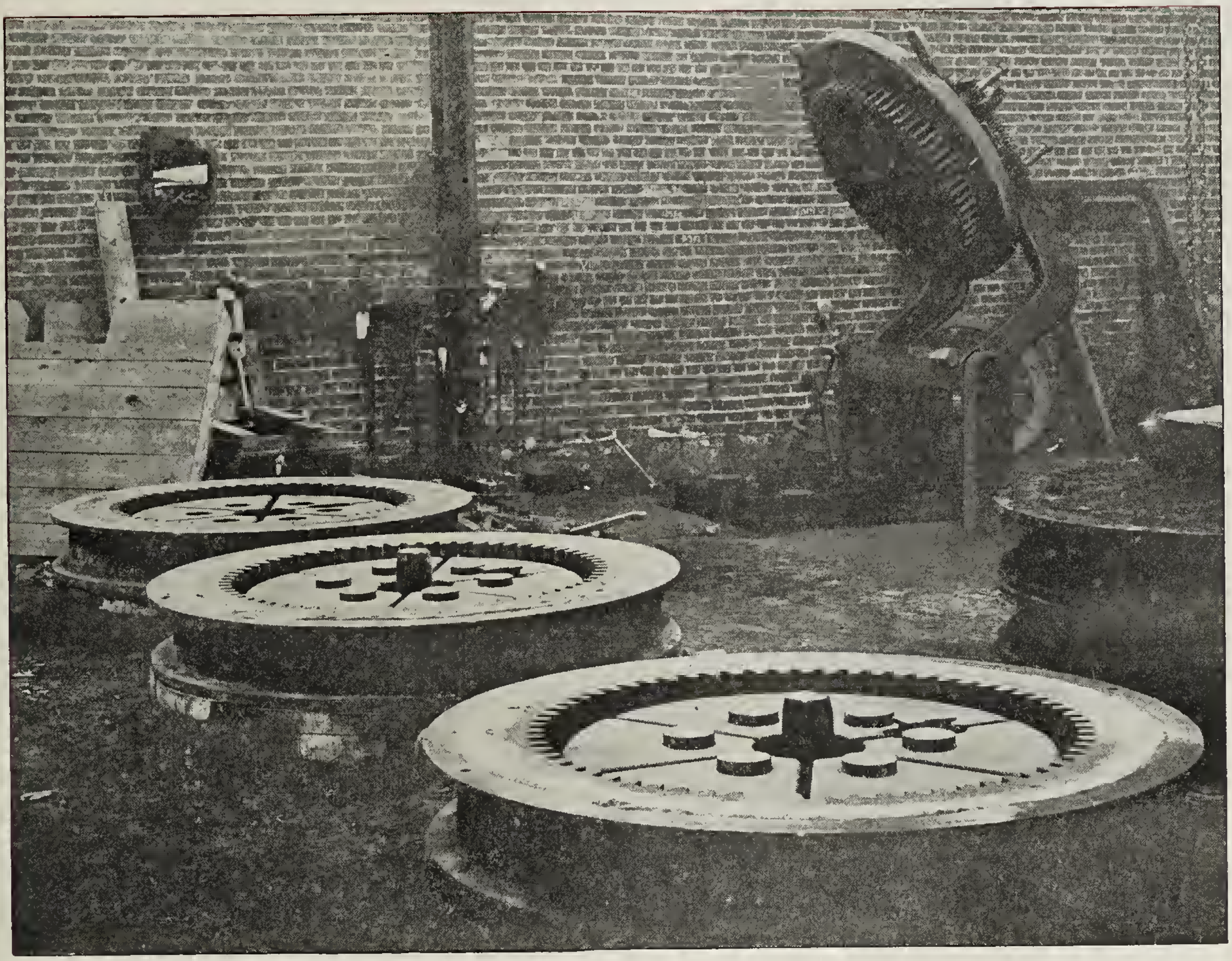
FOREIGN AGENTS
Geo. W. Goodchild & Macnab, 56 Eagle St., Southampton Row, London, W. C.; Fenwick, Freres & Co., 8 Rue De Rocroy, Paris, France.

FOREIGN AGENTS
Mitsui & Co., Ltd., New York, Tokio, Japan; Benson Bros., Sydney and Melbourne, Australia

MUMFORD

ELIZABETH, N.J.

PATENTED
MUMFORD
MOLDING
MACHINES
E.H. MUMFORD CO.
ELIZABETH, N.J.



MUMFORD MADE

Gear Molds

A few 59" Winch Gear Molds, with 6" Draw. Made on Mumford 44" Jolt-Rock-Over Draw Machine (Patented), from wooden Patterns, without special rigging of any kind. Jolt Rammed and drawn by machine. Production increased over 500%.

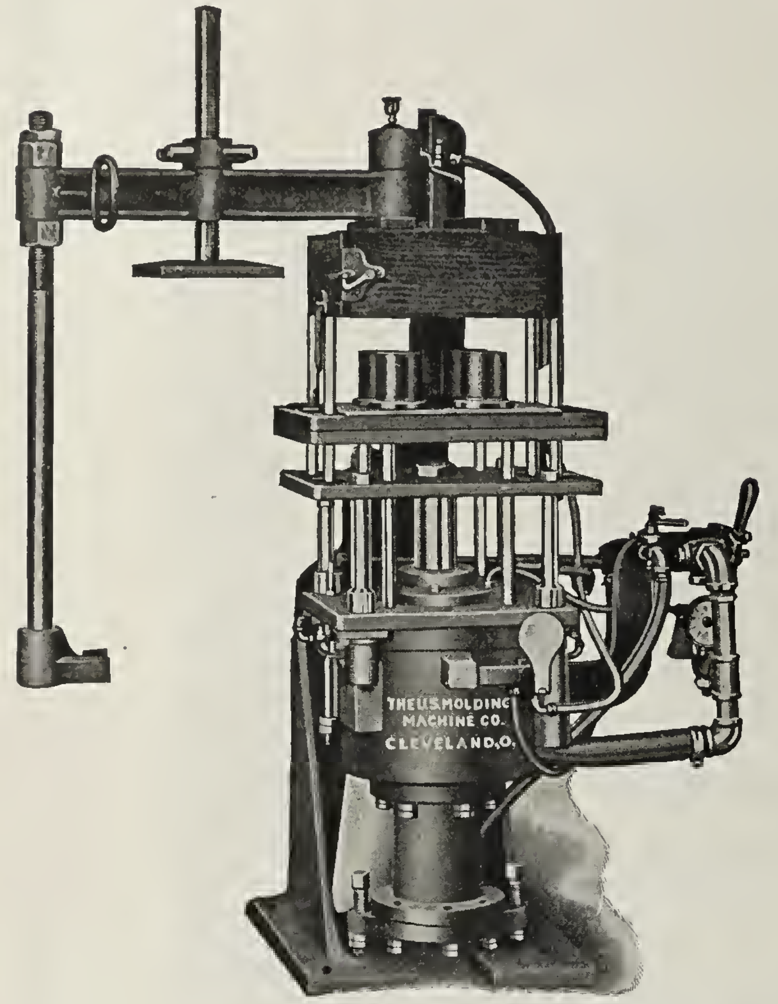
Bulletin R-16 shows operation in detail.
Write for it today.

E. H. MUMFORD COMPANY

ELIZABETH NEW JERSEY

NOTICE! Do not confuse our product with that of the Mumford Molding Machine Co. There is no connection whatever!

The Battenfeld Line



Comb. Jar, Squeeze Pattern Draw

If you did not place your order at the convention

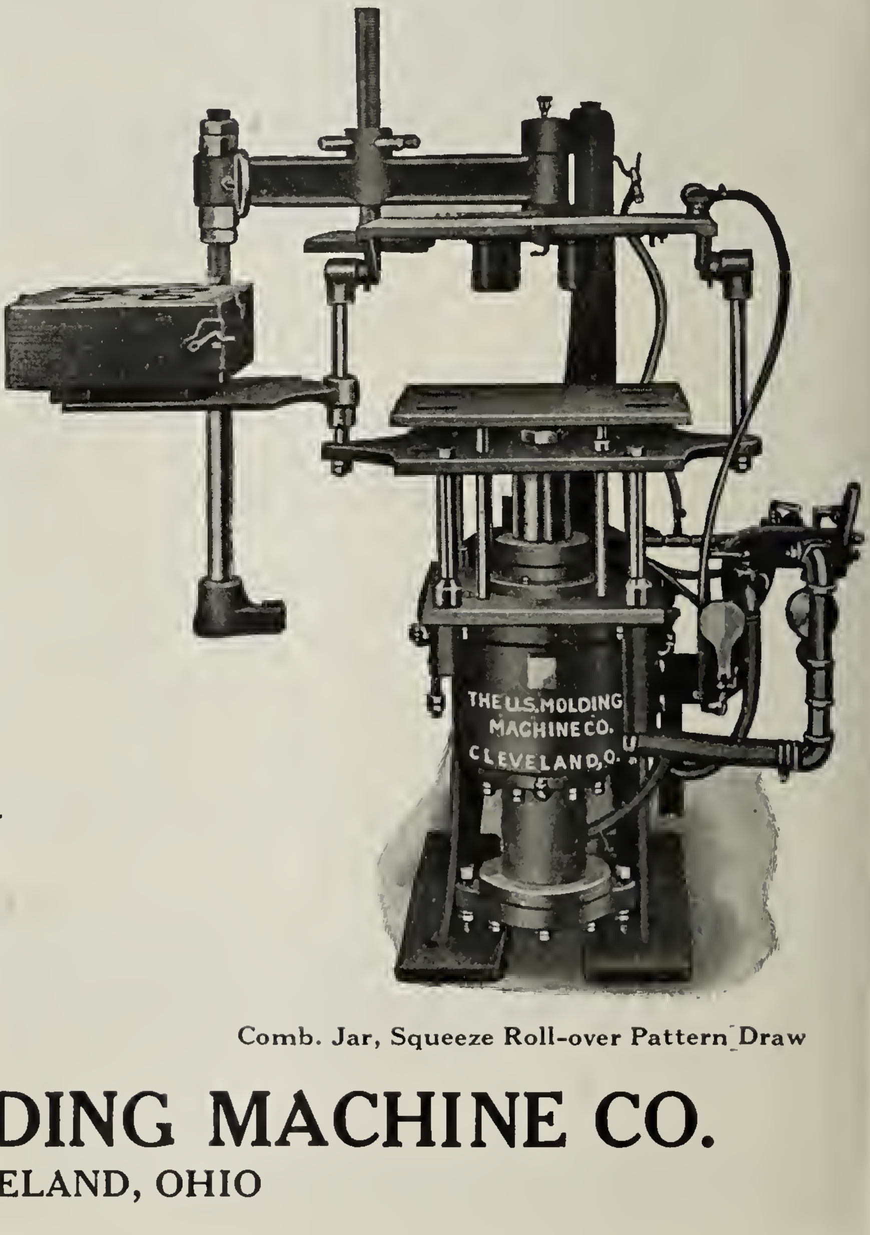
Do so Now.

Get Results.

Our representative will call if you desire.

We manufacture machines for all kinds and sizes of castings.

Air Squeezers
Comb. Jar and Squeeze
Comb. Jar Roll-over
Comb. Jar Pattern Draw
Plain Jarring Machines



Comb. Jar, Squeeze Roll-over Pattern Draw

THE U. S. MOLDING MACHINE CO.

CLEVELAND, OHIO

ARCADE MOLDING MACHINES **ARCADE** MOLDING MACHINES **ARCADE** MOLDING MACHINES **ARCADE** MOLDING MACHINES **ARCADE** MOLDING MACHINES

IN the lists of second-hand foundry equipment you very rarely, if ever, see the name Arcade mentioned. What is the answer ? Clearly it means that Arcade machines are so well built that they last indefinitely. They give such satisfaction that their owners do not dispose of them in the hope of finding something better.

Arcade Jolt, Roll-Over, Pattern Drawing Machine

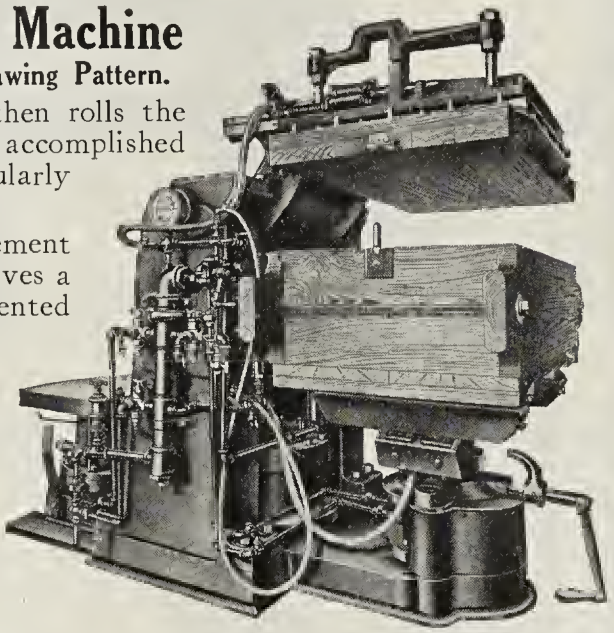
Performs Entire Operation of Ramming and Rolling Mold and Drawing Pattern.

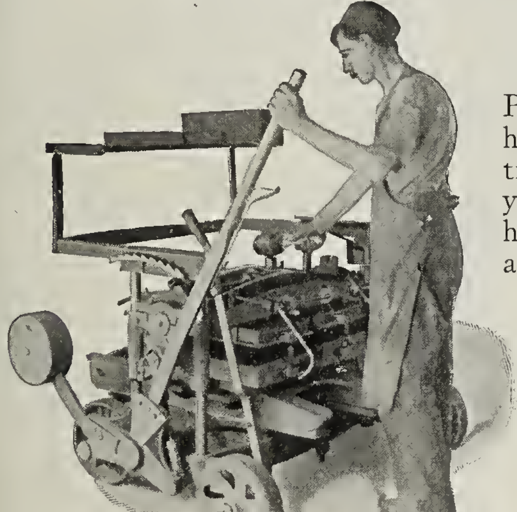
This time-saving, capacity-increasing machine first jolts and then rolls the mold over and draws the pattern. All of these movements are accomplished by compressed air. Drawing the pattern by air is a particularly valuable feature of this machine.

By means of a rack and pinion construction, the forward movement of the piston elevates the table and then rolls it over. This gives a positive and accurate movement that is an original and patented feature of this machine.

Note that all the controlling valves are on one side and are within easy reach of the operator. Each movement of the machine has a separate positive control. This feature is valuable because it prevents the machine from being damaged by an inexperienced operator.

The various operations can be controlled with great accuracy. The machine is strongly built and will give years of service. Furnished in sizes suitable for any foundry.





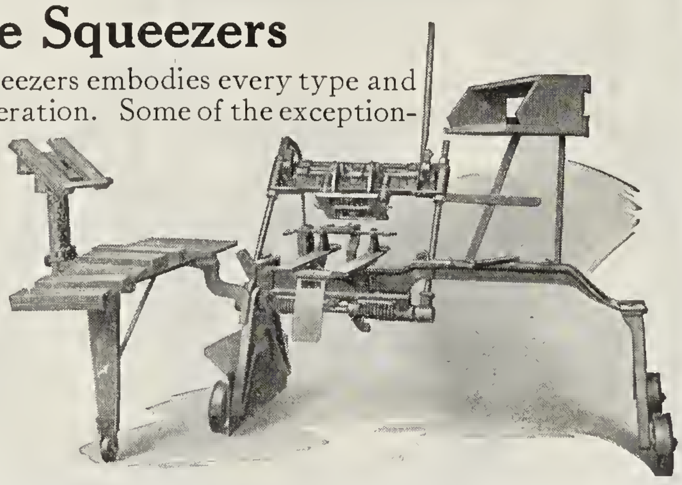
Modern Molding Machines

Perhaps a battery of "Modern Molders" would solve your short-of-help, lack-of-space problem. They require no skilled labor. An untrained laborer will turn out twice as many molds on a Modern as your speediest trained man can turn out by hand. Double output—half the labor cost. The molds from the machine will be absolutely accurate and uniform—castings will require little or no machining.

Let us tell you what the Modern will do in your foundry—how it will increase your profits and turn out better work. Won't cost you a cent—puts you under no obligation. If our investigation shows that you cannot use Modern Molding Machines to advantage, we'll frankly tell you so.

Arcade Squeezers

The Arcade line of squeezers embodies every type and size for air or hand operation. Some of the exceptional features of all Arcade Squeezers are great range in head adjustment—ease of operation—and sand-proof bearings.

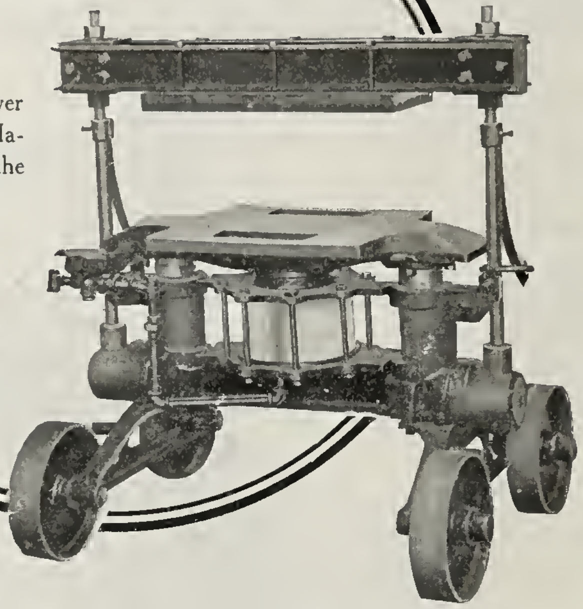


No. 10X illustrated at right is a simple, inexpensive, practical squeezer for even the smallest foundries. It is built to straddle the sand heap, thereby avoiding all unnecessary handling of sand. Illustration shows machine complete, equipped with cope rest, flask guide and pneumatic vibrator. This is an excellent all-purpose squeezer at a price within reach of any foundry.

Write for Catalog 27
showing entire line of Arcade money-making machines for foundries.

ARCADE MFG. CO.
Dept. 00 **FREEPORT, ILL.**

ARCADE MOLDING MACHINES **ARCADE** MOLDING MACHINES **ARCADE** MOLDING MACHINES **ARCADE** MOLDING MACHINES **ARCADE** MOLDING MACHINES



Portable Power Molding Machine of the "Bee Line."

Trade Mark

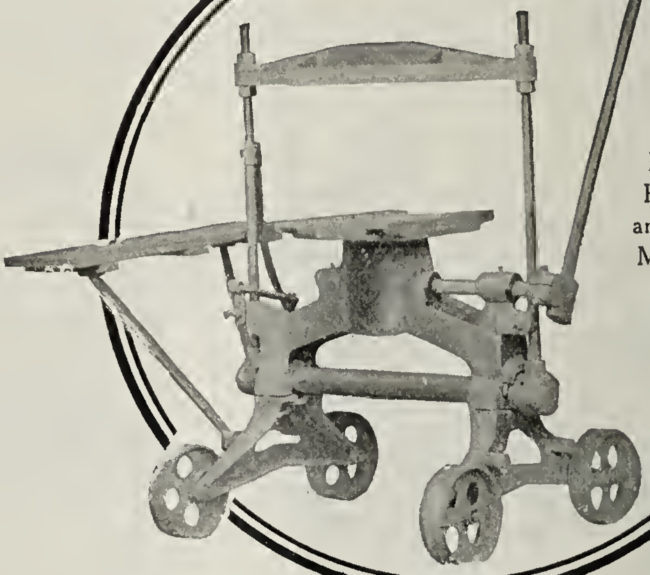
Pick from the
BEE-LINE
for
EFFICIENCY

The only way that labor shortage can be overcome in the foundry is by the installation of faster producing molding methods.

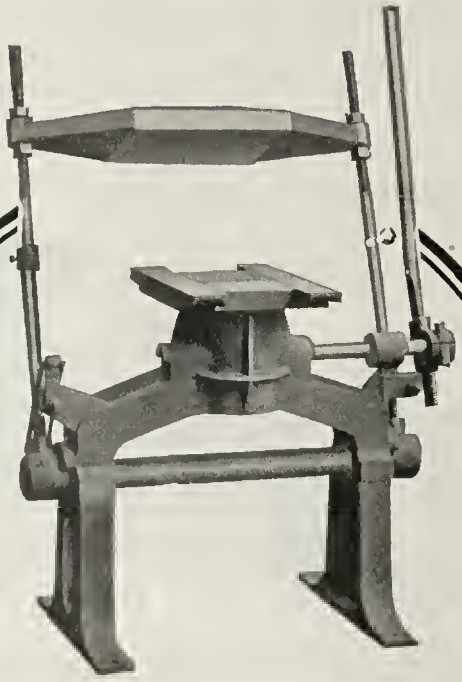
Bench and floor molding are back numbers where speed is required.

The molding machine is the only answer to this problem.

But there's a difference in molding machines. Pick from the "Bee Line" and you will choose the most efficient machine for its purpose.



Portable Hand Jar and Squeeze Machine of the "Bee Line."



Stationary Hand Jar and Squeeze Machine of the "Bee Line"

"Bee Line" molding machines are ***speed*** machines. They operate quickly, easily, and accurately.

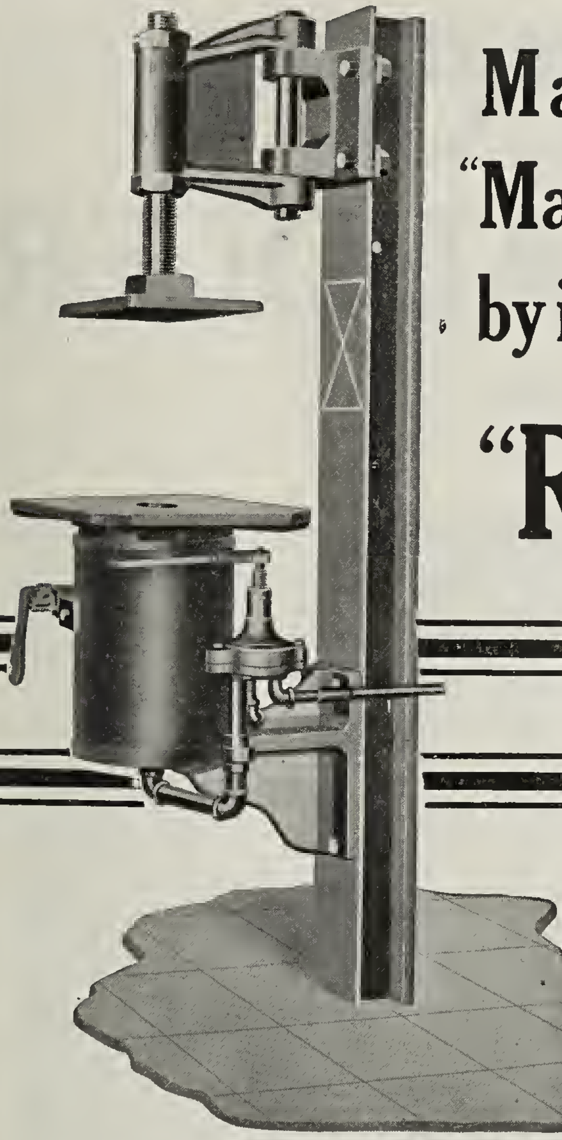
Built in power or hand type—portable or stationary.

Write for full particulars.

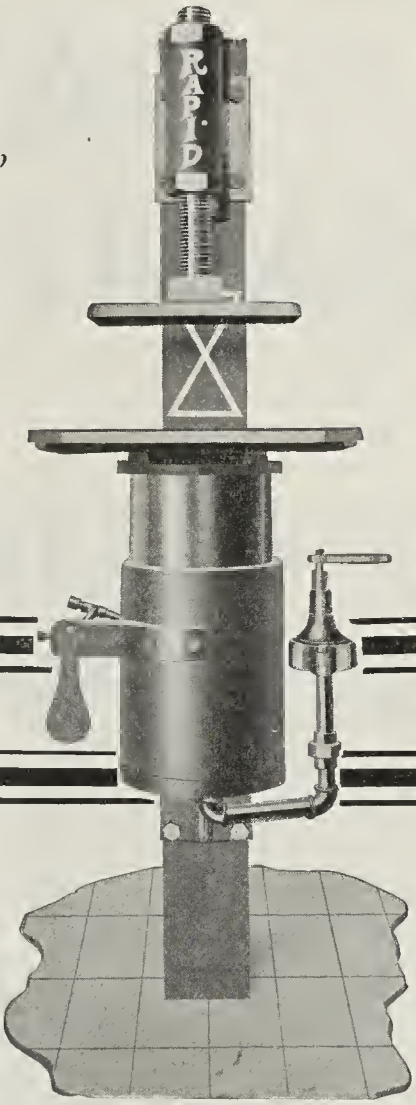
The B. & B. Mfg. Co., Inc.

Indianapolis, Inc.

Canada, Castings of Ottawa, Ottawa
England, Ley's Malleable Castings Co., Ltd., Derby



Make up for "Man Shortage" by installing the "RAPID"



THE RAPID MOLDING MACHINES

The greatest problem confronting the foundryman today is "man shortage".

Every foundry has contributed liberally to Uncle Sam's fighting forces. Consequently, production has suffered. It has been almost impossible to find others to fill the places of the men who have answered their country's call.

Rapid Molding Machines will solve *your* "man shortage" problem.

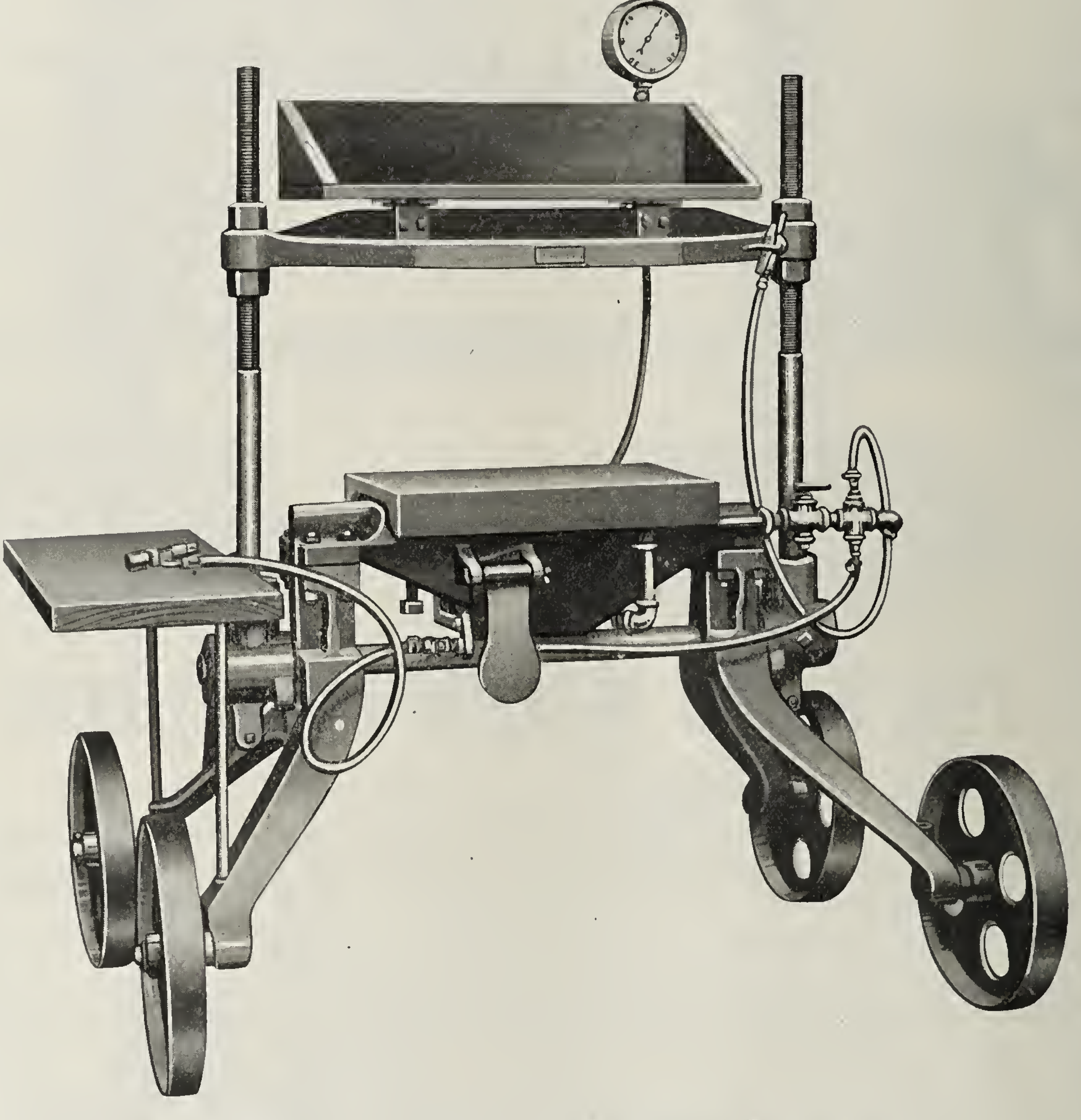
Their *speed* and *accuracy* will more than make up for your shortage of men. They are being used with maximum efficiency in steel, malleable, grey iron and brass foundries all over the country.

One malleable foundry installed one machine and then ordered twelve more—another malleable foundry put in one and ordered six more—still another tried one and immediately ordered ten more. Other repeat orders are coming in daily.

The "Rapid" has proved to be the best solution to the "man shortage" problem in the foundry. *It is the only machine of its kind or class in existence.* Let us ship you one.

FEDERAL MALLEABLE CO.
WEST ALLIS, WISCONSIN

DAVENPORT SAND STRADDLER



The Davenport Line of Molding Machines

JOLTS JOLT SQUEEZERS SQUEEZERS

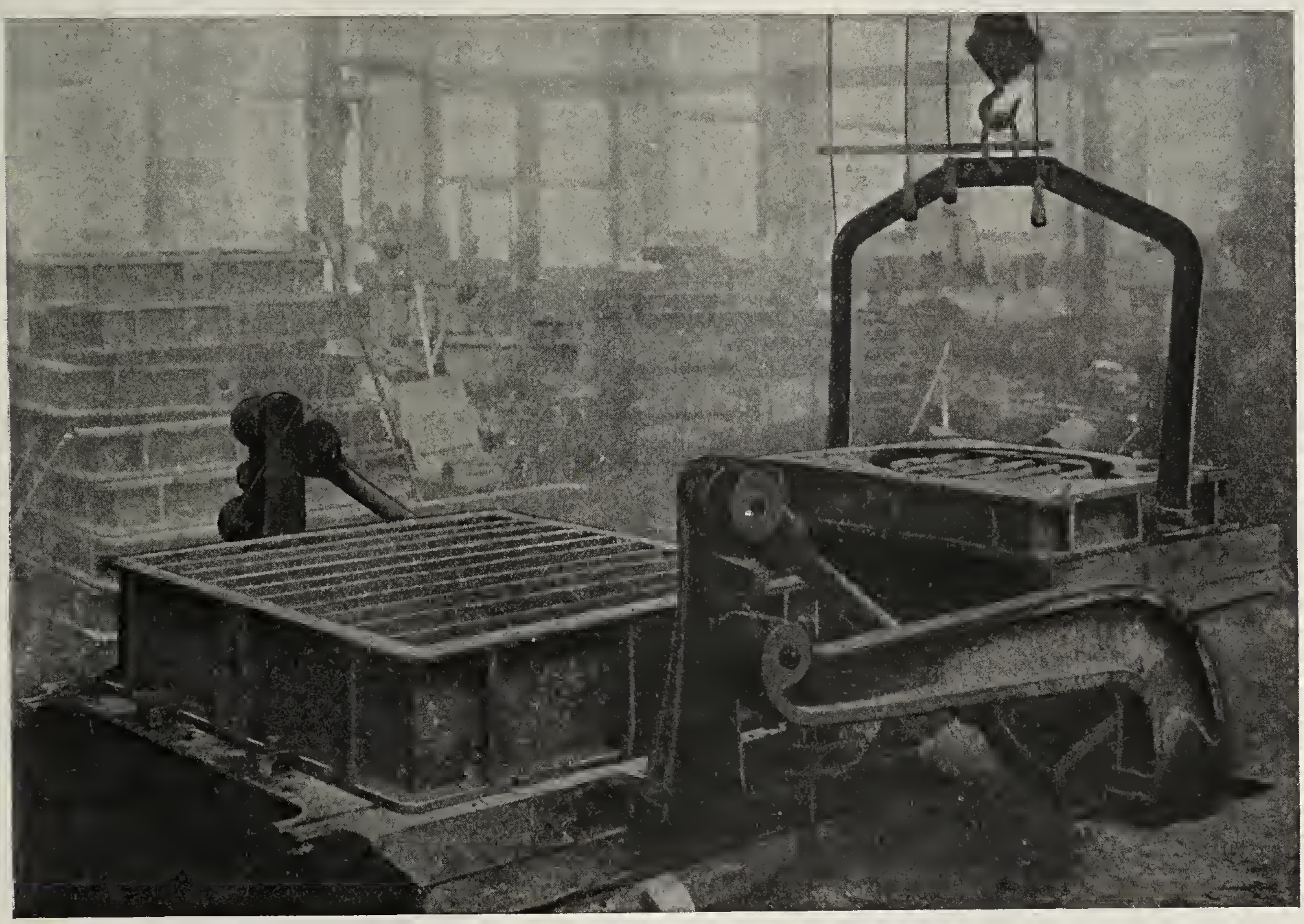
JOLT ROCK OVER HAND RAM ROLL OVER

Davenport Machine & Foundry Company

Davenport, Iowa

If it's a Herman, it's worth using,
It made its way by the way it's made

Hundreds of important foundrymen have recognized the completeness of machine shown in accompanying cut which is known as our Jarr Independent Rollover and Pattern Drawing Machine. This machine jarrs the mold, turns over the flask which is lowered from the pattern and the rollover plate with pattern turned back onto table plate of jarring machine, all by power. It requires less crane service and manual labor to operate than any molding machine built. We will appreciate explaining the important features of this machine to foundrymen who are interested in a machine for medium and larger sized molds.



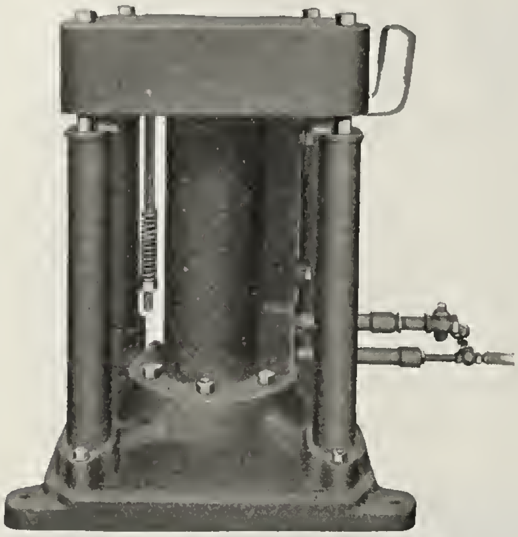
The machine that does all of the work except shoveling sand.

Plain Jarring Machines, Jarr Strippers, Jarr Squeezers, Jarr Rollovers and Jarr Core Machines made in sizes to suit your requirements.

Please let us have your inquiry

Herman Pneumatic Machine Company

GENERAL OFFICES: Union Bank Building, PITTSBURGH, PA.
MANUFACTURING PLANT: ZELIENOPLE, PENNSYLVANIA, U. S. A.
Foreign Works: Pneumatic Engineering Appliances Co., Ltd., Palace Chambers, Westminster, London, S. W., Eng.



THE AMERICAN
JOLT STRIPPER

Simply and rigidly constructed.

One piston jolts mold and draws pattern.

No auxiliary cylinders.

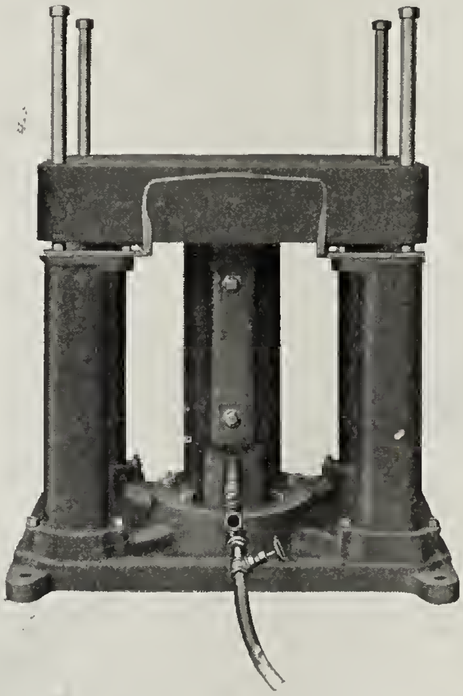
No bell cranks and levers to get out of alignment.

Extra long guide, permitting extreme pattern draft.

All working parts amply protected, insuring long life of machine.

The Illustration above shows the normal or jolting position of the American Jolt Stripper.

One cylinder jolts the flask and draws the pattern.

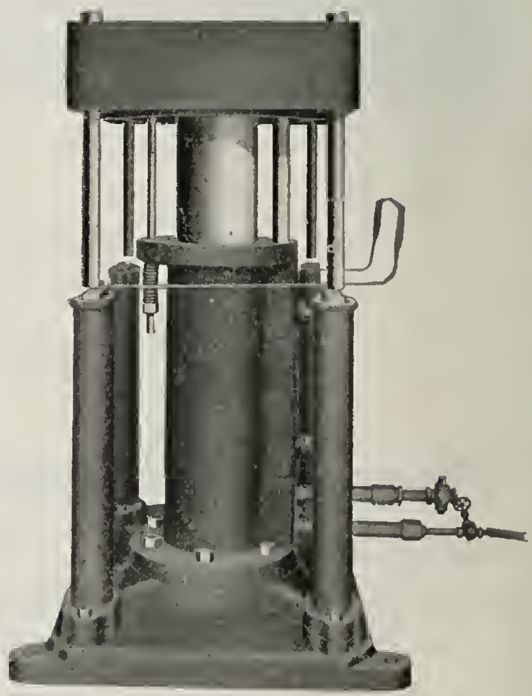


The stripping operation is performed by first raising the flask to the full height of the draw in which position it is held by four steel rods as illustrated below.

The pattern is drawn through the stripping plate by exhausting the air slowly from the cylinder.

This operation leaves the stripping posts projecting upwards through the table, forming a support for stripping plate and mold—illustrated above.

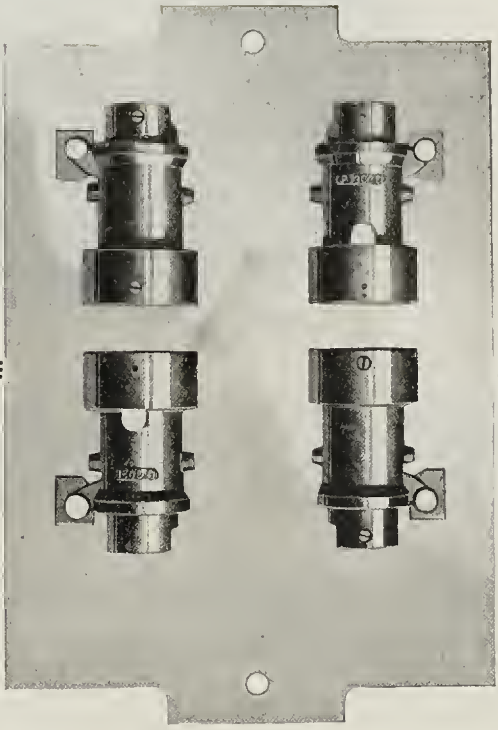
Let us send you complete description and price of this modern molding machine.



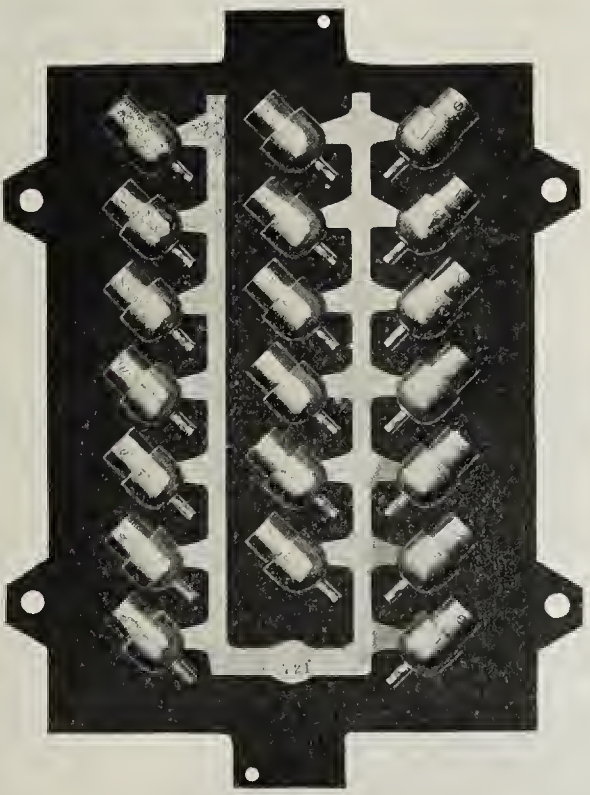
American Molding Machine Co.

W. C. NORCROSS, Pres. and Gen. Mgr.
TERRE HAUTE, IND.

MOLTRUP'S FLATTENED STEEL PATTERN PLATES



"They are as straight as our patterns"



say the foundries that use them

This is how we do it.

We take the rough, hot rolled plate and cut it to your required sizes. They are then flattened—hand hammered to remove all the rolling kinks and waves. All scale, pit marks and imperfections are ground out, and then the plates are polished. Finally they are straightened again to a straight edge and are ready for attaching patterns without machining the surface.

Moltrup's Steel Pattern Plates are made in any required thickness and any shape or size.

Send us your specifications.

MOLTRUP STEEL PRODUCTS CO., Beaver Falls, Pa.

Boston: Edgar T. Ward's Sons. New York: Geo. Nash Company. Chester, Pa.: Allison & Company. Chicago and Detroit: Central Steel & Wire Company. San Francisco: Milton Pray.

Sterling

Rolled Ribbed Channel Steel Flasks

are replacing wooden and cast iron foundry flasks at so rapid a rate that we are pushed night and day to keep pace with our orders.

In rushing times like these, maximum efficiency must be secured from every department of every foundry—hence the demand for strong, light, accurate, safe, easily-handled foundry flasks.

Sterling Steel Flasks fully measure-up to the most exacting requirements of gray iron, steel and non-ferrous bench—floor—and machine molding work. They can't crack or burn.

Every Sterling Flask is built-to-order, to fit the exact conditions of the work it must do. Our process of manufacture insures accuracy of dimensions to the 100th of an inch and the alignment of pin-centers to the 1000th of an inch.

Steel is the ideal material for foundry flasks, and the ribbed flange used in making Sterling flasks gives maximum strength with lightness.

Our Reinforcing flanged angle on medium and large flasks, and our flasks for steel foundry or other hand service, have multiplied the usefulness of the Sterling line.

We are still able to make reasonably prompt deliveries; but conditions are growing more strenuous every day, and steel is harder and harder to obtain—at **any** price.

We are therefore advising our friends to get under cover without further delay.

Send for our Catalogue giving full details

Sterling Wheelbarrow Company

64th Avenue
Milwaukee,
Wisconsin

Makers of Patented Ribbed Channel Steel Foundry Flasks, Snap Flasks, Skim Gates, Wedges, Foundry and Contractors' Wheelbarrows and carts, General Wheelbarrows, Trucks, Carts, etc.

Put life into your molding
Speed up your floors

Diamond Flasks and jackets, because of their light weight, ease and accuracy of operation, will greatly increase your production.

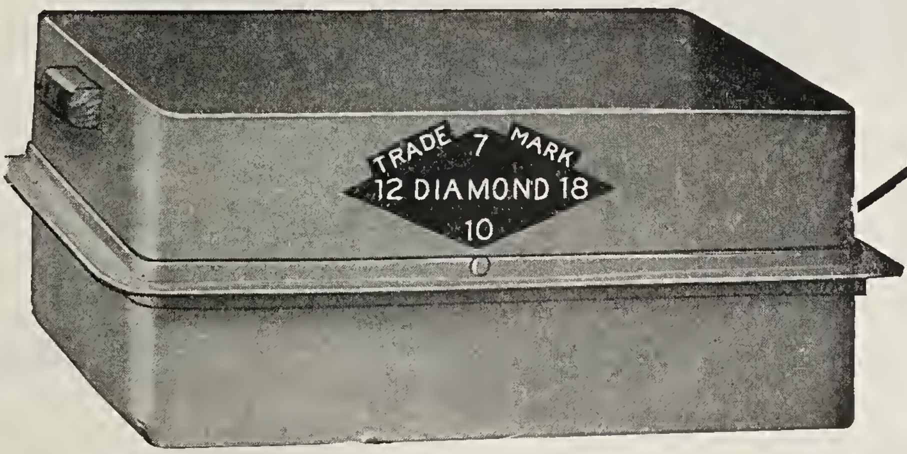
They will eliminate the hardest work in your foundry —the shaking out and handling of heavy floor flasks.

Diamond Snap Flasks and Jackets insure economy of floor space, speedier production and the elimination of the continual expense connected with the upkeep of floor molding equipment.

Made in any size or shape desired.

Write for our new catalog.

We also manufacture a complete line of foundry accessories. Wedges; Clamps; Varnish Cans; Pattern Benches; Core Boxes; Rapping Plates; etc.



DIAMOND CLAMP & FLASK CO.

38-40 N. 14 St.
RICHMOND, INDIANA

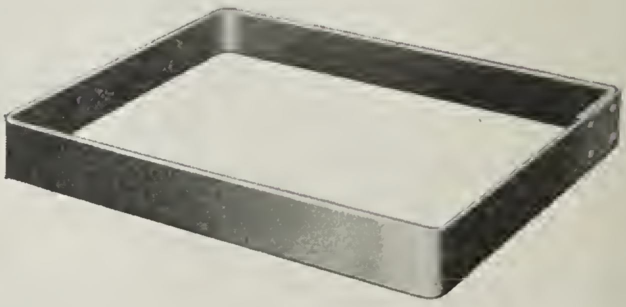
Protect Your Moulds
with
Peck Steel Bands and Jackets

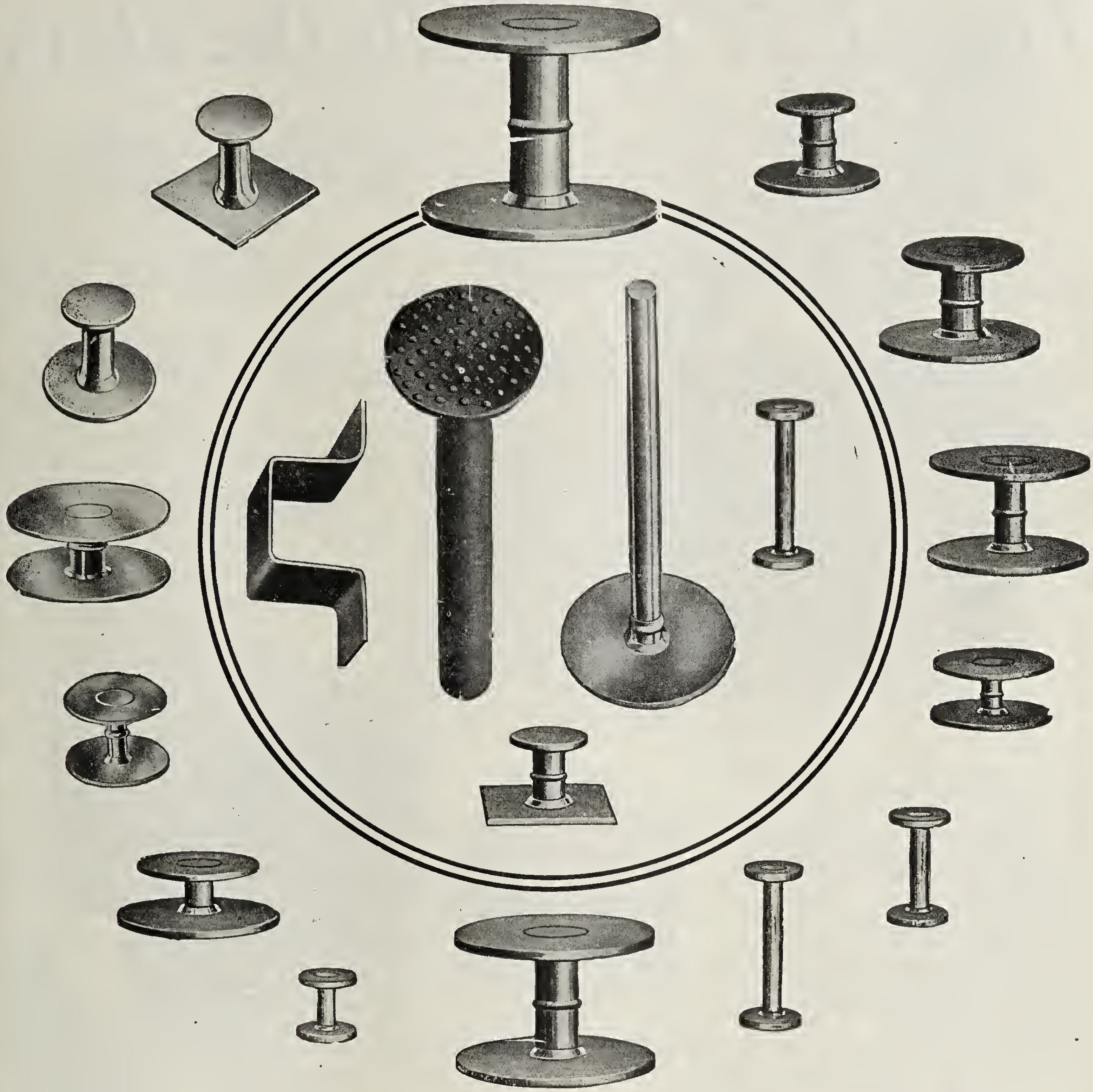
They will last for years, but will pay for themselves in a short time.

Save that loss of CASTINGS. Make them perfect. Cut down that grinding expense and use less floor space.

PECK IRON & STEEL WORKS
Kalamazoo, Mich.

Manufacturers of
Foundry Equipment
Wood and Steel snap flasks
Bands and Jackets Trucks
Hand Ladles Tote Pans





Lindsay Chaplets

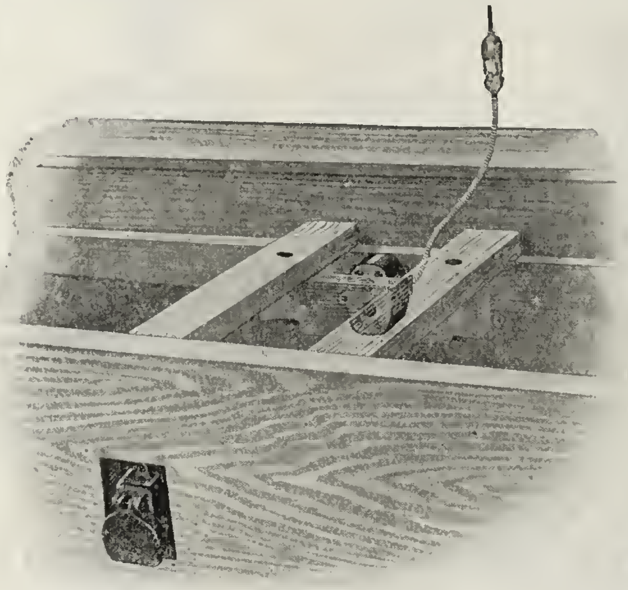
W. W. Lindsay & Co., Inc.

Harrison Building

Philadelphia, Pennsylvania

The TEST that tells the story

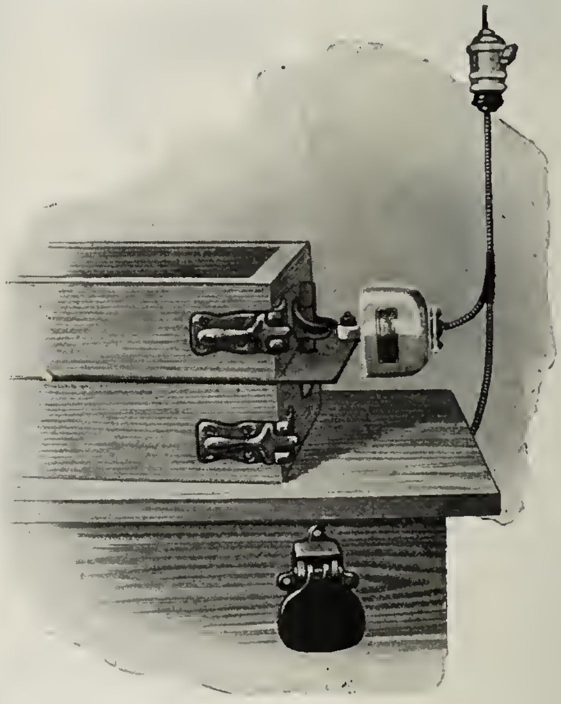
The illustration at the bottom of the page shows an L & A Electric Vibrator, with the case partly opened, entirely submerged in a jar of water. This vibrator has been running for two months under these conditions, and is every bit as good now as it was at the start. This test thoroughly proves that the "L & A" is ***built*** right. The reorders we get for it prove that it ***does the work*** right.



THE
L & A Electric Vibrator

(Protected by U. S. and Canadian Patents)

always proves an immensely profitable investment. Its extreme simplicity, small first cost and low operating expense make it the choice of the thinking buyers. It requires no expensive air compressor or generator. It operates from an ordinary light line at less than one cent a day. Notice the table shown below, which is based on a molder working eight hours a day and the vibrator one minute in every four—the basis of cost per kilowatt being five cents.



The Pressed Steel Company,
Muskegon, Mich.

Gentlemen:-

This is to advise you that the fifty vibrators purchased from you in May 1916 are still in service and are giving the best of satisfaction.

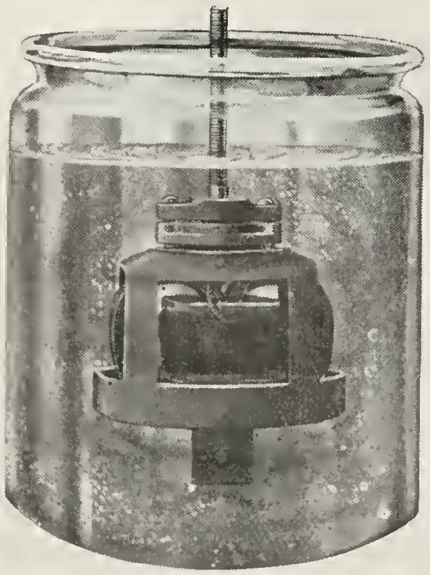
We were interested to know the operating cost of these vibrators and have just completed a month's test that proved very gratifying to us. We had a wattmeter installed that would record the current consumption of one vibrator on a molding machine. During this test there were 7656 molds made at a current consumption of 3 kilowatt hours. According to that it has cost us approximately four cents to run the vibrator for one month. We would be pleased to verify the afore mentioned test for any parties interested in vibrators for foundry use.

We are going to install twenty five more machines in the near future and assure you that they will be equipped with the L & A Electric Vibrator.

Yours very truly,

The Piston Ring Company

Paul R. Bardsley
Sec'y-Treas

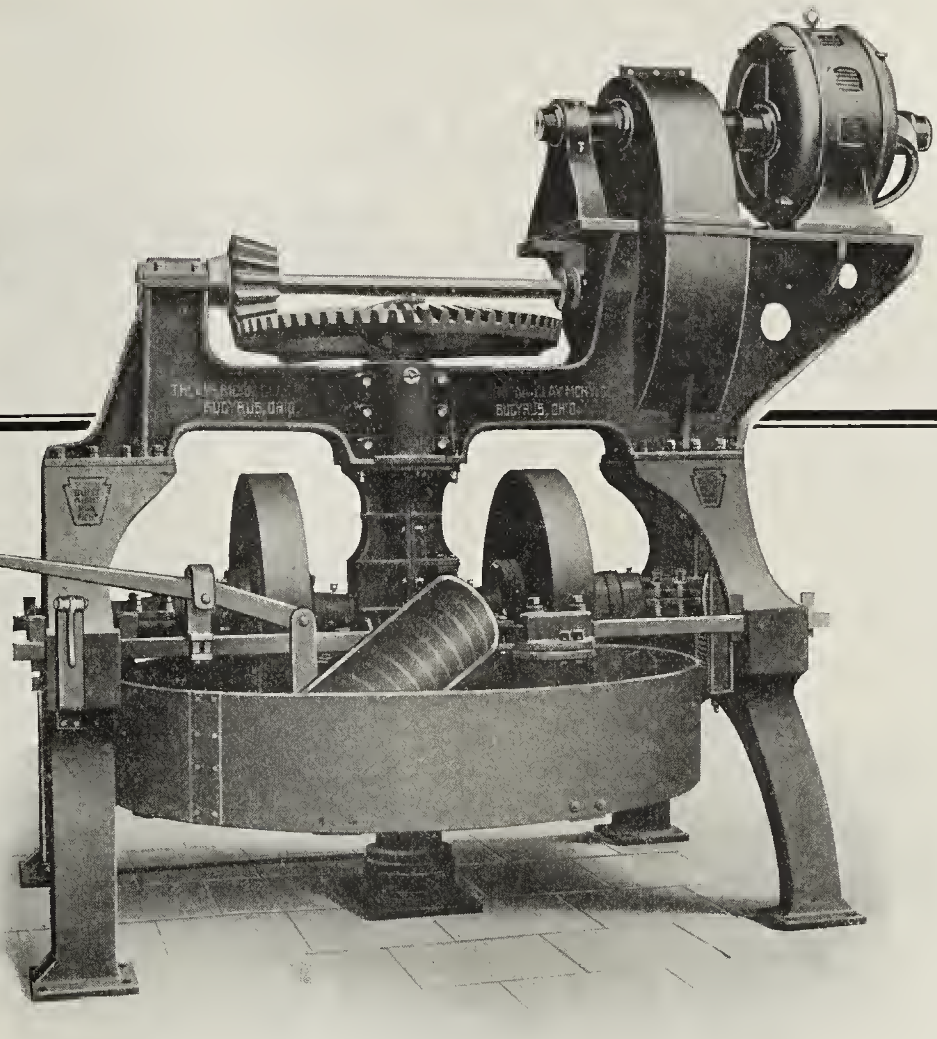


Size	Weight	Cost per day to operate	Equivalent to Air Vibrator	Price
1	2¼ lbs.	.6c	½"	$10.00
2	2¾ lbs.	.7c	⅝" - ¾"	12.00
3	3¾ lbs.	.8c	1" - 1⅛"	14.00
4	4¼ lbs.	1.0c	1¼" - 1½"	16.00
Knee Switch				2.50

Prices shown are F. O. B. factory.

Sold direct and by leading jobbers.

The Pressed Steel Company
MUSKEGON, MICHIGAN



AMERICAN GRINDING PANS

UNCLE SAM IS CALLING FOR YOUR HELP!

The War Must be Fought With Smoke-stacks as Well as With Cannon.

Upon the efficiency of American factories, steel plants and foundries, depends the duration of the struggle. Their ability to meet government demands promptly and efficiently will greatly shorten the war.

Are you prepared for any emergency? Is your foundry equipped with modern and efficient machinery?

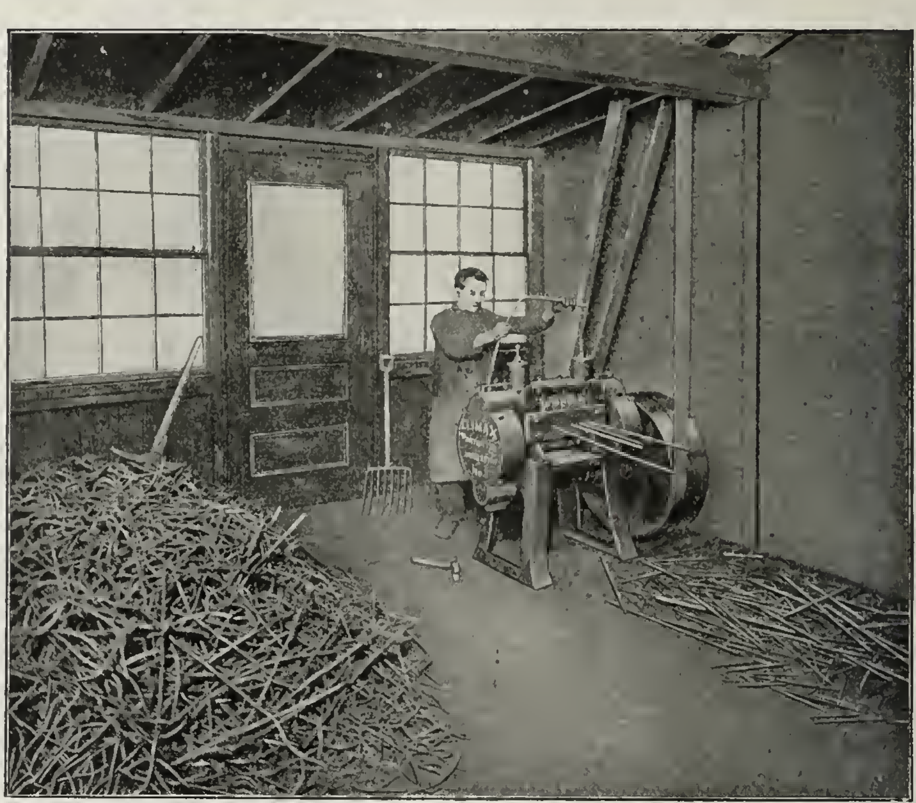
American Grinding Pans are standard equipment for all American Foundries.

They reclaim your core sand and economize on core oil, saving as high as $5.00 a barrel on oil. In a foundry employing from 25 to 30 molders, an American Grinding Pan will pay for itself in less than a year.

Uncle Sam is calling for your help in conservation, Here's How.

American
Clay Machinery Company
Bucyrus, Ohio

Put these two paying machines to work for you



Turning Twisted Wire Into Dollars and Cents

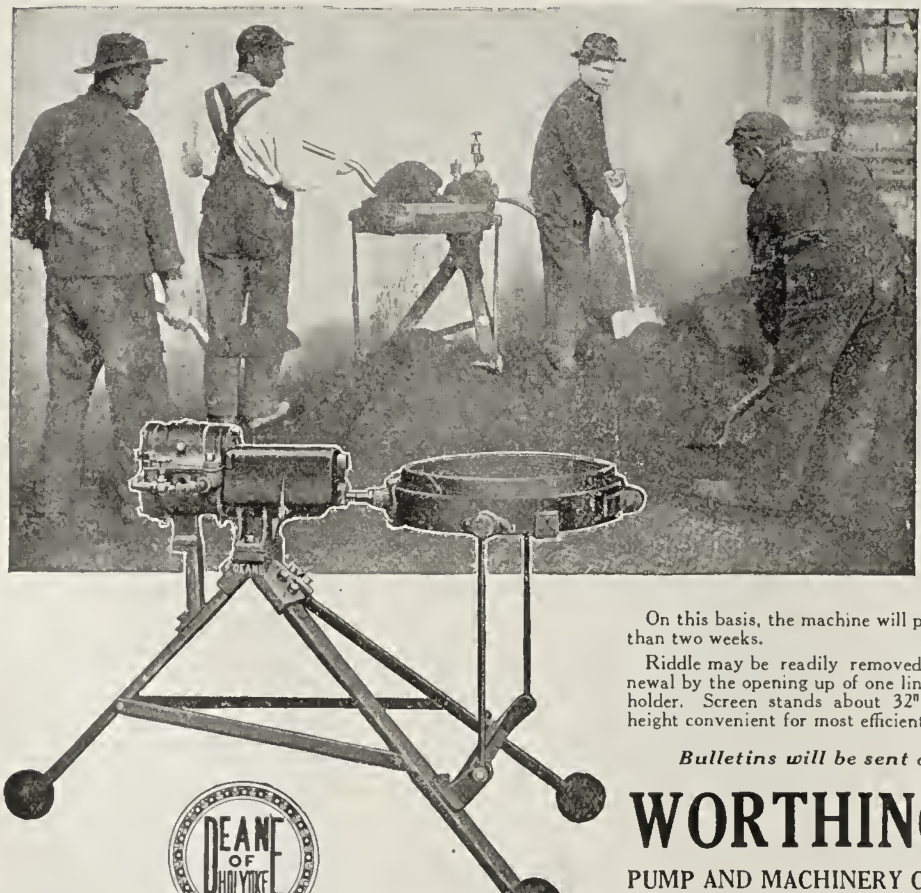
It is a waste to throw out used core wires, when you can quickly and easily straighten a whole scrap heap of bent and twisted wires; you can be independent of wire shortage and slow deliveries, and save a big item of wire expense with a

BLAKE-KNOWLES

Core Wire Straightener

The Core Wire Straightener is simple enough for a boy to operate. It takes only a little time each day to feed your bent wires into the machine, which turns them out perfectly straight and ready to be used again. The Blake-Knowles Straightener has a strong, durable, cast iron frame made in one piece. The rollers are forged nickel, case hardened steel. It can be operated by electric motor, small gasoline, gas or oil engine. Will straighten all sizes of wire from $\frac{1}{16}$" to $\frac{3}{4}$".

Riddles a Cubic Yard in Five Minutes



DEANE OF HOLYOKE

DEANE

OF HOLYOKE, MASS.

Sand Riddle

screens fast enough to keep five men busy shoveling, while one man can shovel fast enough to keep two men busy with hand riddles.

If laborers are paid $1.75 per day, and if it is assumed that the charges on the machines are the same as for one laborer—a generous allowance for maintenance—then the following comparison may be made:

By Power

One machine—maintenance . .	$1.75
Five men shoveling, at $1.75 .	8.75
	$10.50

By Hand

Ten men riddling at $1.75 --	$17.50
Five men shoveling at $1.75.	8.75
	$26.25

By Hand	$26.25 per day
By Power	10.50 per day
Saved by machine . .	$15.75 per day
	123.8

On this basis, the machine will pay for itself in less than two weeks.

Riddle may be readily removed for repair or renewal by the opening up of one link in front of riddle holder. Screen stands about 32" above floor at a height convenient for most efficient operation.

Bulletins will be sent on request

WORTHINGTON

PUMP AND MACHINERY CORPORATION

115 Broadway, NEW YORK

Atlanta Boston Buffalo Chicago Cincinnati
Cleveland Denver Detroit El Paso Houston
Kansas City Los Angeles New Orleans
Philadelphia Pittsburgh St. Louis Salt Lake City
San Francisco Seattle St. Paul Tulsa

A machine may save a world of time and wither your payroll and yet be a poor buy

How about the quality of the work it turns out? That's the test.

These foundries use Blystone Sand Mixers—first because of the thorough mix.

Westinghouse Electric & Mfg. Co.

Allis-Chalmers Mfg. Co.

U. S. Cast Iron Pipe & Foundry Co.

United Engineering & Foundry Co.

Lidgerwood Mfg. Co.

Buffalo Forge Co.

Emerson-Brantingham Co.

Dayton Engineering Laboratories Co.

—and a thousand others.

The commanding dominance of the Blystone Sand Mixer is due first of all to the surpassing quality of its work—the complete and uniform mix.

The reverse spiral shoveling action crushes, kneads, grinds and smooths the mix to absolute uniformity.

A Blystone ***feature*** is that you can throw a different material into each end of the drum and the resulting mix will be the ***same*** throughout the whole mass.

Judge a mixer first by the quality of the mix—and you'll buy a Blystone—by every test.

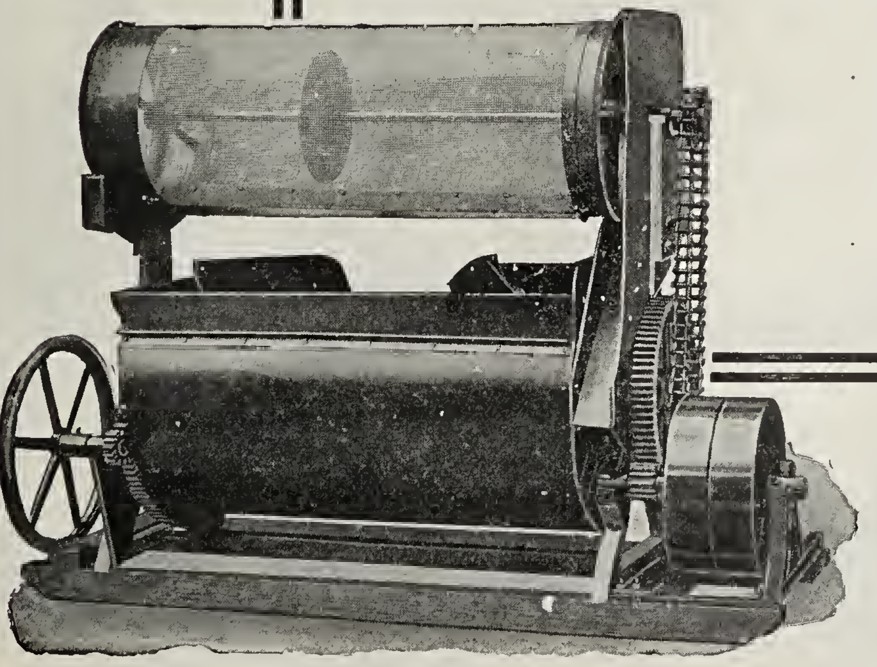
Let our engineers help you solve your mixing problems on a quality basis as well as on a speed and labor saving basis.

Write or Wire

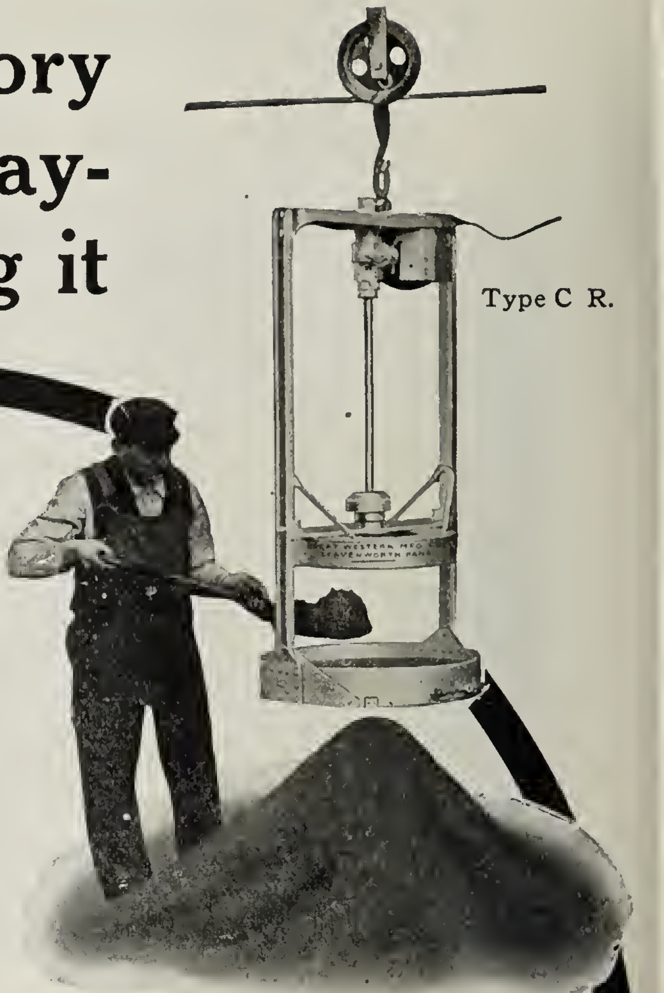
The Blystone Sand Mix
Known as the thorough mix

Blystone Manufacturing Co.
1217 Ironton St. Cambridge Springs, Pa.

Wonham, Bates & Goode, Incorporated, New York City
Scully-Jones & Co., Chicago, Illinois
Frederic B. Stevens, Detroit, Michigan
J. S. McCormick Company, Pittsburgh, Pennsylvania
E. B. Fleury, Toronto, Ontario, Canada
The Hill & Griffith Company, Birmingham, Alabama
Standard Supply & Equipment Co., Philadelphia, Pennsylvania
F. G. Anderson, 421 Engineers Bldg., Cleveland, O.



Doing without a Gyratory Foundry Riddle means paying for it without getting it



Type C R.

Evenly mixed and tempered sand not only reduces the time of making the mold, but insures a better mold with fewer patches after the pattern is drawn. This saving increases the output of each man and assures castings that are truer to pattern.

TYPE C R. Combs' Gyratory Foundry Riddle is built along the lines of our original riddle, but is made heavier and stronger in every way. The sieve is 24" in diameter and is easily removed. The motor is one-third horsepower, totally enclosed, and can be driven from a lamp socket.

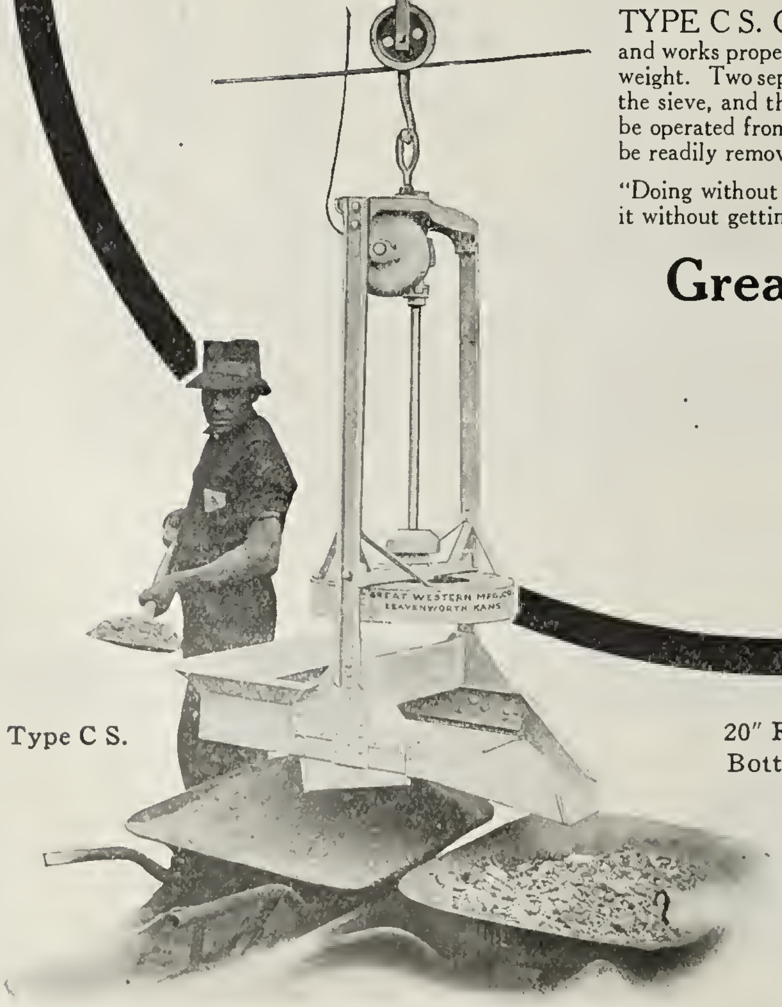
This machine was specially designed to meet the demand of foundries desiring a greater capacity than can be obtained from our "Type V."

COMBS'
GYRATORY FOUNDRY RIDDLES

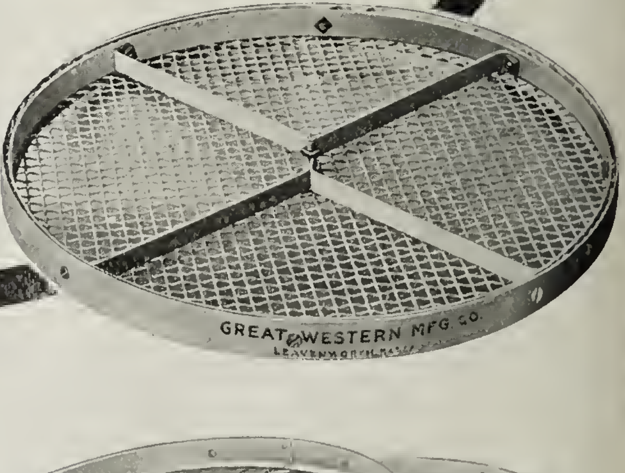
TYPE C S. Combs' Gyratory Foundry Riddle is portable and works properly when suspended from anything that will sustain the weight. Two separations are made, screened sand passing down through the sieve, and the refuse trailing off to one side. This type can also be operated from any lamp socket. The sieve is 24" square and can be readily removed by loosening two nuts.

"Doing without a Combs' Gyratory Foundry Riddle means paying for it without getting it." Let us send you one on 30 days' trial.

Great Western Mfg. Co.
Leavenworth, Kansas



Type C S.



20" Removable Bottom Sieves

Read What One User Says of the "Champion"

"Your motor driven riddle is one of the things we are not sorry to have to pay for. Our foreman says it has proven one of the best things he ever tried out. We would be pleased to have your catalog of other foundry appliances."

The superior capacity of the CHAMPION RIDDLE is due to the elliptical motion, which also produces the "kick" necessary in a machine which is to be used for mixing core sand, facing and general foundry purposes.

The patented portable feature of the CHAMPION makes it easy to move to any part of the foundry or core room. It is equipped with a ¼ H. P. motor. This ample power insures maximum capacity and long life.

The motor and all working parts are entirely enclosed and thoroughly protected from sand.

The CHAMPION RIDDLE is constructed entirely of steel and fitted with ball bearings throughout.

Send us a trial order stating terms and voltage.

Champion Foundry Machinery Co.

2423-2425 West 14th Street **Chicago, Ill.**

Pettinos
MOULDING SAND

If you desire to make high grade castings, you must insist upon using high grade moulding sands.

Pettinos Sands—*Albany, North River, Jersey, Lumberton* and *Millville*—are carefully selected, first quality sands.

They will serve your purpose better and cheaper.

We have a complete line of high grade equipment. Above is illustrated one of our locomotives with cars.

PETTINOS PLUMBAGO

Our production of pure Plumbago Dusts, Blackings, etc., are standard the world over.

We mine, refine and ship direct to you, insuring lowest prices.

We specialize Ceylon Foundry Plumbagos and carry large stocks in spite of present transportation difficulties.

The *right* Plumbago for your work means a saving in castings. TRY US. Orders filled promptly.

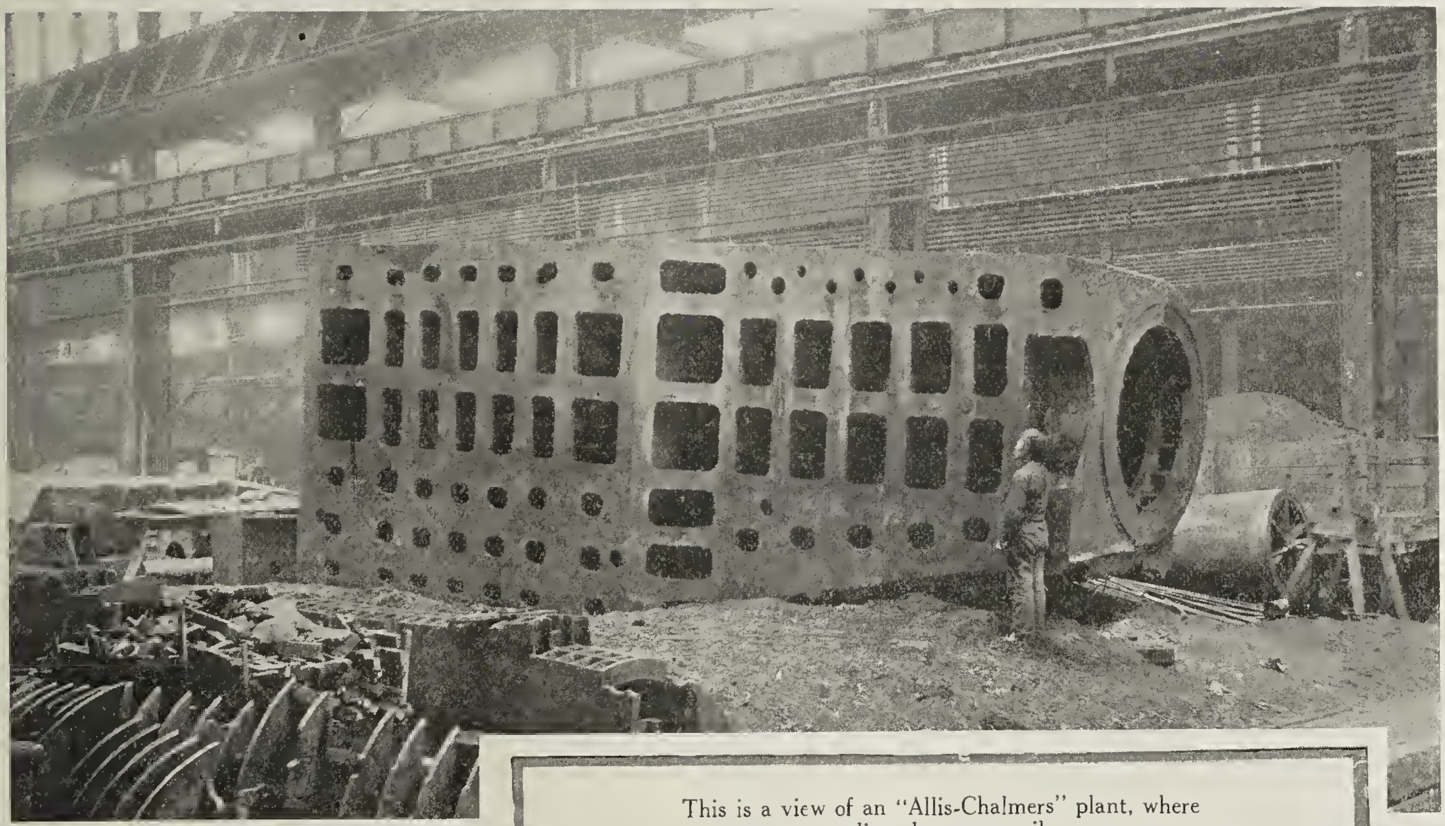
GLUTRIN IN STOCK.

PETTINOS BROTHERS
BETHLEHEM Main Office, NEW YORK PHILADELPHIA

Portage Sands

are Found

wherever "High Grade Work" is the Slogan



This is a view of an "Allis-Chalmers" plant, where quality always prevails.

Allis-Chalmers Manufacturing Co.
uses Portage Sand Blast Sands

And numerous other important concerns throughout the country, depend upon Portage Sands, too.

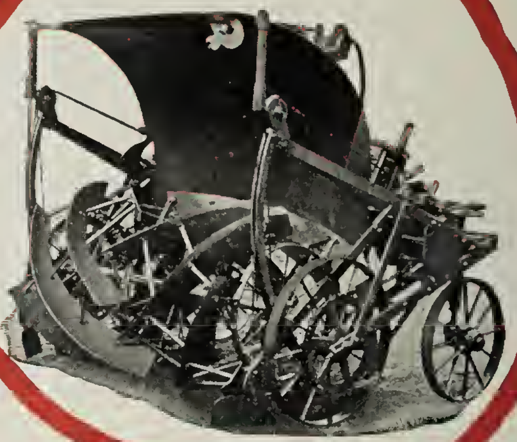
Portage Sand Blast Sands are clean, hard, sharp and uniform. They average over 98% Silica. Portage Steel Molding Sand will save from 35 to 40 per cent of your molding sand bills. Why not follow in the footsteps of the successful ones, and specify "Portage"?

We'll be glad to fill your next requirements or send you samples. Which shall it be? *WRITE US.*

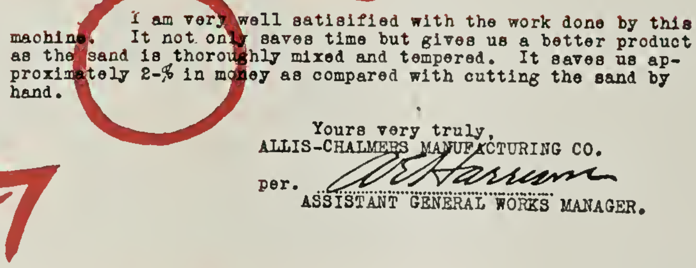
The Portage Silica Co.

YOUNGSTOWN, OHIO

20% Saved



AUTO SAND CUTTER



I am very well satisified with the work done by this machine. It not only saves time but gives us a better product as the sand is thoroughly mixed and tempered. It saves us approximately 2-% in money as compared with cutting the sand by hand.

Yours very truly,
ALLIS-CHALMERS MANUFACTURING CO.
per.
ASSISTANT GENERAL WORKS MANAGER.

A Correction

This letter was one of five which appeared in our November issue. Through error in reproduction it read 2% instead of 20%

THE SAND MIXING MACHINE COMPANY, Inc.
52 Vanderbilt Avenue, New York, N. Y.
Factory: Cleveland, Ohio

FULL-TIME SAND BLAST

What is the net efficiency of your sand blast apparatus in hours per day?

Can your operator work continuously, or does he have to emerge frequently for air, like a diver, to avoid suffocation?

Why condemn a man to the lung-destroying atmosphere of the old-fashioned sand blast room, and yourself lose 20% or more of the time-efficiency of your investment, when he could work all day, without danger or discomfort, with the

American-Wadsworth "Humane" Room

High Pressure
Simple
Rapid
Standardized
Successful

OPERATOR'S POSITION—OUTSIDE

AMERICAN FOUNDRY EQUIPMENT CO.
THE SAND MIXING MACHINE CO., Inc.
52 Vanderbilt Avenue, New York City
Factory: Cleveland, Ohio

SAND BLAST AND ALLIED EQUIPMENT

PANGBORN EQUIPMENT MAKES THE BEST INVESTMENT

"ASK THOSE WHO KNOW BY WORKING COMPARISON"

The largest plant in the world manufacturing Sand-Blast and Allied Equipment
(Experience, Capital and Facilities Unequalled)

IT PAYS TO SAND-BLAST

For It Always Improves the Product and Usually Reduces the Cost

F. S. BLACKWOOD, President GEORGE S. STAGE, Treasurer

THE BLACKWOOD STEEL FOUNDRY CO.
STEEL CASTINGS OF QUALITY
Springfield, Ohio

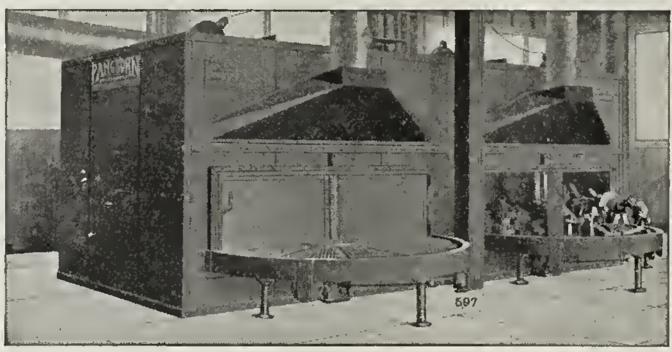
Pangborn Corporation, February 22nd, 1917.
Hagerstown, Md.

Gentlemen: (Attention Mr. J. C. Pangborn)

We have your letter of recent date with reference to the two (2) complete Room-Table Sand-Blast Installations, which you furnished us, and we beg to inform you that they are giving us the very best satisfaction in every way.

When we were selecting the equipment for this new plant you will recall our having told you that we wanted everything of the very best so as to enable us to turn out high grade steel castings at the very lowest possible cost.

Although the price of your Sand-Blasts was higher than the others we, nevertheless, were satisfied from our experience and investigation that there was even a still greater difference in the merit of the different equipments, and we placed the business with you feeling that the "PANGBORN" Sand-Blasts would be the cheapest in the end and, therefore, make us the best investment.



(Part of the Installation Referred to)

The efficiency of everything pertaining to your equipment has proven to be exceedingly high and the cost of operation and maintenance unusually low. The way in which you exhaust the dust and illuminate the rooms makes the operating conditions ideal. The Arrester takes care of every particle of the dust and the discharged air from the Exhauster, which is being sent directly back into our Finishing Department, is perfectly clean.

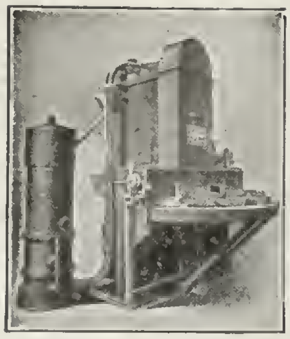
We are more than pleased with having selected "PANGBORN" equipment and with our dealings with you as a whole.

Very truly yours,
THE BLACKWOOD STEEL FOUNDRY COMPANY.
AB-y A. F. BLACKWOOD, President.

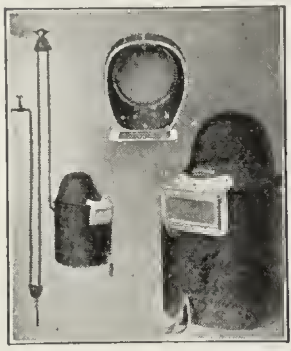
Equipment of every type for every requirement
DUSTLESS — AUTOMATIC — SELF-CONTAINED
Literature for the asking. Representative thoroughly conversant will call and acquaint you fully without obligation.

Sand-Blast and Allied Equipment Exclusively

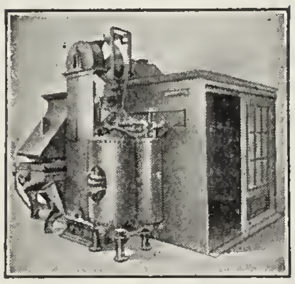
PANGBORN
CORPORATION
HAGERSTOWN, MD.
SAND-BLAST SPECIALISTS
P. O. Box 851



"LB" Table Sand-Blast

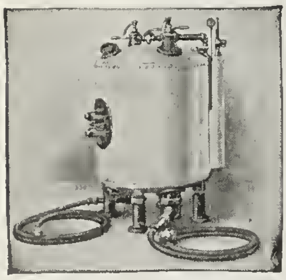


"D" Ventilated-Dustless Helmet

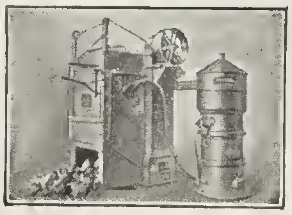


"L" Room Sand-Blast

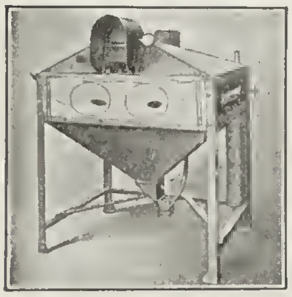
"CB" Dust Arrester



"AG" Hose Sand-Blast



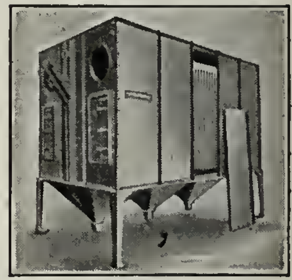
"GC" Barrel Sand-Blast



"EA" Cabinet Sand-Blast

"AC" Hose Sand-Blast

"GB" Barrel Sand-Blast



"CC" Dust Arrester

"BG" Sand-Separator

"L-CC" Room Sand-Blast

"PC" Room Sand-Blast

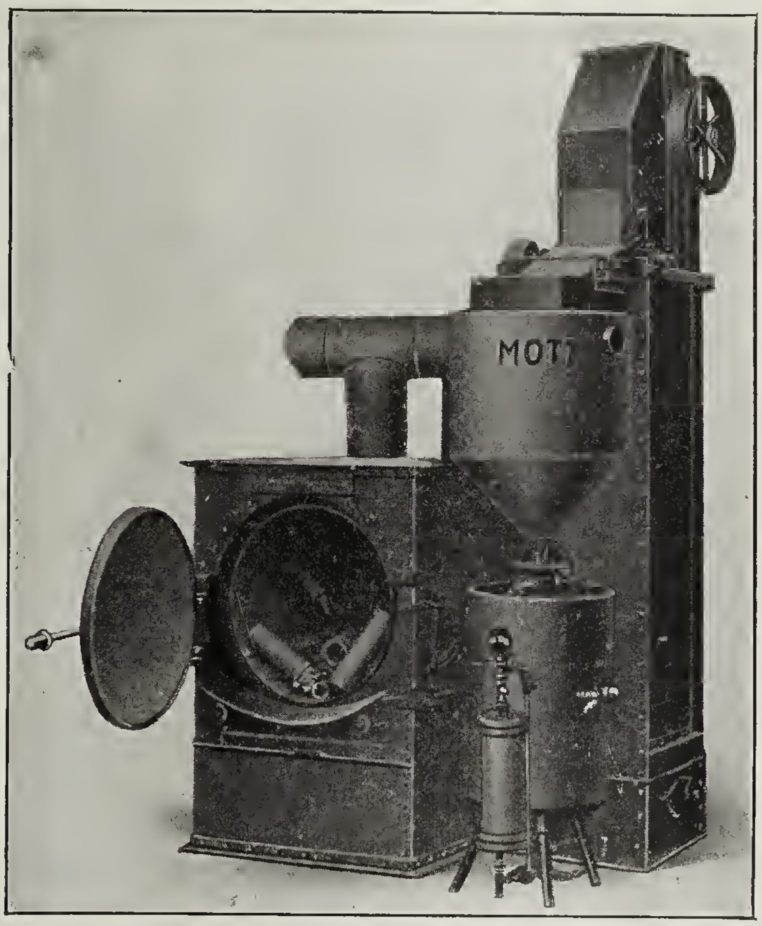
"DC" Sand Dryer

MOTT

SAND-BLAST EQUIPMENT

This is the machine that created so much interest at the Foundry Convention.

We manufacture a complete line of Sand-Blast Room Accessories.



THE MOTT SAND BLAST BARREL MACHINE
TYPE P. E. S. SINGLE

Makes your cleaning room a real paying investment

Mott Sand-Blast Equipment reduces labor cost—increases production—and assures better cleaned castings.

We design, build and install complete Sand-Blast *plants, cleaning rooms, hose machines, barrels, revolving tables, sliding tables, cabinets,* etc.

We also manufacture a complete line of Sand-Blast Room Accessories, *hoods, gloves, hose, respirators, nozzles, abrasives,* etc.

Write for our catalog.

MOTT SAND BLAST MFG. COMPANY, Inc.

EVERYTHING IN SAND BLAST
NEW YORK
8 Frost St., Brooklyn, N. Y.

DESIGNS FURNISHED
Chicago
24-30 South Clinton St.

DOELCAM

Sand Blast Barrels, Tables, Cabinets and Hose Machines, Sand Blast Accessories

Here's a Barrel Doing Three Times as Much Work as a Competing Barrel

Send Particulars of Your Requirements to

THE MACLEOD CO., Bogen St., Cincinnati, Ohio

A Practical Text Book On Sand Blasting FREE For The Asking.

DEMAND for FLINT SHOT came from such a surprising variety of industries besides those we had counted upon, that we saw the need of detailed knowledge of actual shop practice.

We, therefore, made a first hand study of Flint Shotting in plants of many kinds, from Illinois to Massachusetts, and developed a vast fund of useful information—carefully authenticated—for all users of sand blast; as well as for all industries still clinging to the slow and costly practice of pickling, tumbling, wire brushing, etc.

The *"Little Journeys of the FLINT SHOT Man"* have now been put into a Book, the only approach to a text book on sand blasting thus far written. It is of interest in every industry where metal surfaces are cleaned, by whatever process or material.

The book is yours for the asking.

FLINT SHOT
TRADE MARK - REGISTERED

FLINT SHOT MAGNIFIED

UNITED STATES SILICA COMPANY
Sole Producers of Flint Shot
419 Peoples Gas Building
CHICAGO, ILL.

Give him what he wants!

**KELLER-MADE
MASTER-BUILT**

First of all, let me ask you to write me the kind and number of pneumatic tools you use in a year, so I can make you a special money-saving proposition.

As I said in my "ad" last month, the advertising experts told me you would not do this—but you did, a ***great many of you.*** If you did not do so then, ***do it now.***

Give your men what they want.

Co-operate with the efficiency impulse of the man who uses the tool—you can do it profitably.

Riveting Hammers, Chipping Hammers or Sand Rammers—your men demand special qualifications from ***each.***

In a Riveting Hammer he wants the utmost interchangeability between long and short pistons—so he can use the one best suitable for the work—and this is what he gets in a Keller Master Riveting Hammer.

In Chipping Hammers he wants the utmost hard-hitting effectiveness—and he gets it in the Keller because of the straight-line-air-travel valve.

In a Sand Rammer, he wants the steady action and high speed operation that means uniform tamping—and the Keller Master Rammers, fill the bill.

I wish you could see our catalog. It is not only good to look at, but it shows you the full Keller line; makes you realize that our slogan Keller-Made Master-Built means a high standard of superiority.

Why not let me make you a definite proposition aimed to save you money, and give you better tools? Just write me.

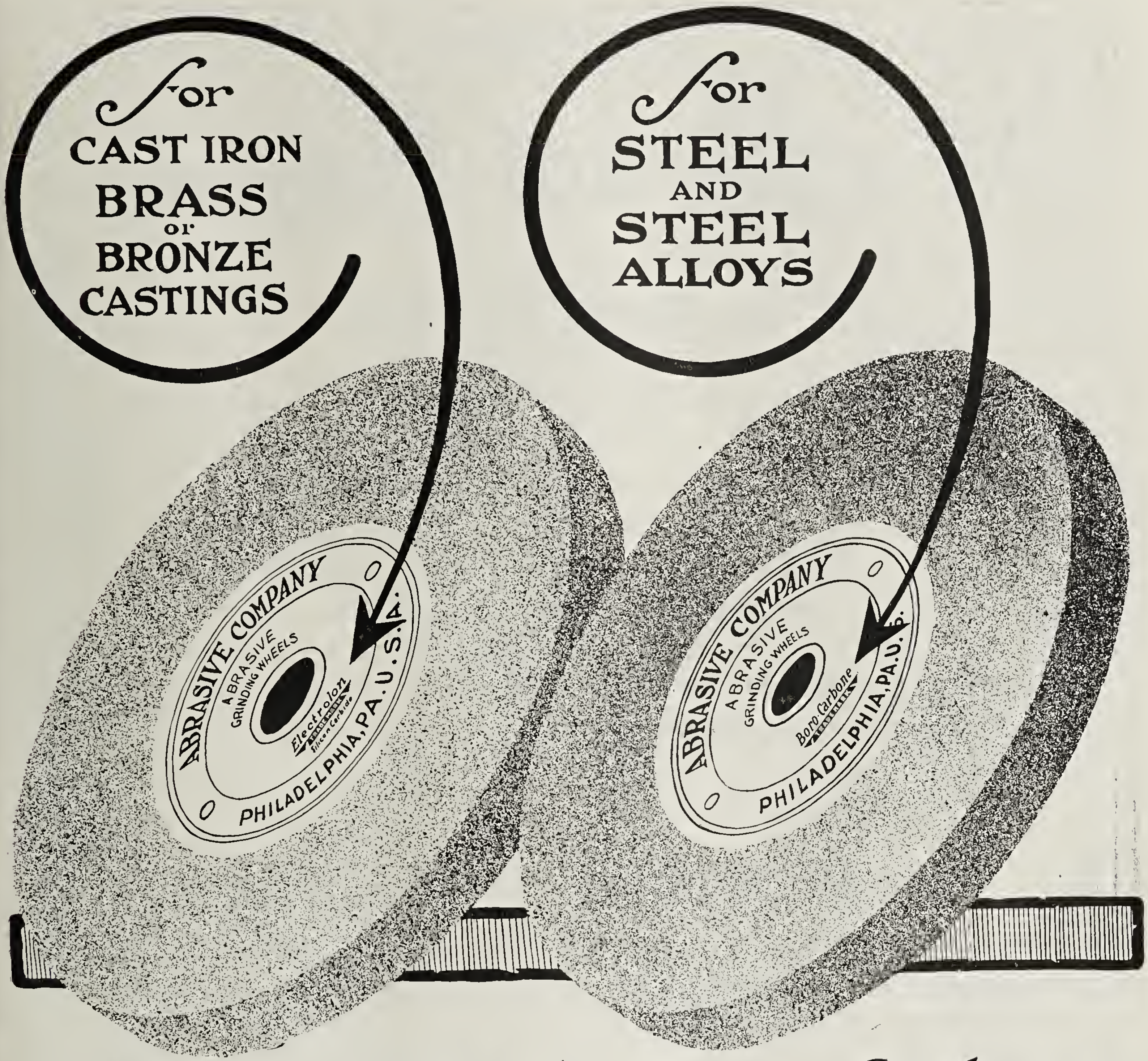
W. H. Keller

Keller Pneumatic Tool Co.
FOND DU LAC, WIS.

KELLER PNEUMATIC TOOLS

For
CAST IRON
BRASS
or
BRONZE
CASTINGS

For
STEEL
AND
STEEL
ALLOYS



Electrolon
TRADE MARK

Particularly adapted to grinding materials of low tensile strength.

"Electrolon" Wheels are always a guarantee of better results and lower operating costs.

Made in all sizes and types.

Boro-Carbone
TRADE MARK

Has no superior for cutting all kinds of steel and materials of high tensile strength.

We make wheels for practically every grinding operation.

Insure greater production and lower operating costs by putting your grinding problem up to us.

Abrasive Company
PHILADELPHIA, PA., U. S. A.

We are not Playing Checkers

Every man-jack of us at the Carborundum plant is working like the proverbial beaver, for never before has there been such a demand for Carborundum and Aloxite Products.

We are doing our level best to meet this big demand—enlarging our plants, increasing our forces, speeding up production—we are even building a big 20,000 horse power furnace plant in Canada in our efforts to keep up with things.

We have a definite service to perform for we are helping to produce the necessities of war.

Carborundum and Aloxite Products are Doing Their Bit

They are grinding shrapnel shells, high-explosive shells, rifle barrels and parts—grinding bayonets and sabers. They are grinding a hundred and one different parts of the aeroplane and the auto truck, the machine gun and the field gun. They are shaping armor plate and grinding car wheels; grinding plowshares, and the tools of the metal-working trades of the world. They are grinding torpedo tubes and torpedoes, grinding submarine engine bases; beveling the lenses of periscopes and buffing the soles of the army shoes and grinding the shears for the pocket kits of the "Sammies." They are doing a thousand and one war tasks quicker and better than they have ever been done before.

Carborundum and Aloxite products are surely doing their bit, but with it all we haven't neglected for one instant our regular patrons—we are doing all in our power to keep up with the pace; to keep up to the standards of Carborundum service.

THE CARBORUNDUM COMPANY
NIAGARA FALLS, N. Y.

NEW YORK CHICAGO BOSTON PHILADELPHIA CLEVELAND CINCINNATI
MILWAUKEE PITTSBURGH GRAND RAPIDS

Don't make

"LUNGERS"

of your men

Collects all dust heavier than air.

Dust filled air makes bad lungs. Grinding machines and tumbling mills fill the air with a fine abrasive dust which is extremely severe upon the lungs. Protect your men from the menace of the white plague — install a

MORSE Rarefied Dust Collector

The "Morse Rarefied" does excellent work with the most troublesome dust—heavy, gritty or cutting, from emery wheels, sand blasts or tumbling mills.

Being operated on the "rarefied" or partial vacuum principle, the air is *drawn* through the collector, not pushed through as in old style machines. This method gives greater effectiveness and makes the fan last indefinitely because the dust is removed before it reaches the fan.

Make your plant a dustless plant—fit for both men and machinery.

Write for Catalog F-43

The Knickerbocker Company
JACKSON - - MICHIGAN

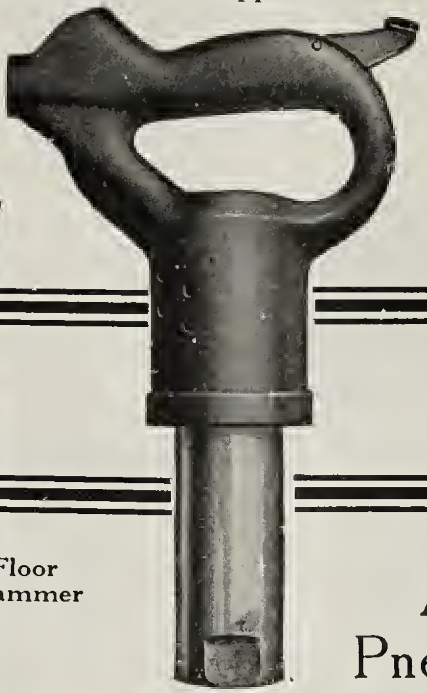
K K

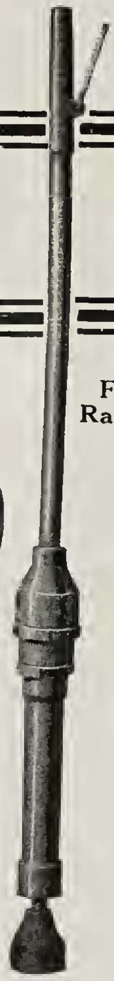
CANTON
PNEUMATIC TOOLS

Canton Valveless Hammer

Bench Rammer

Heavy Duty Chipper





Floor Rammer

Canton Riveter

Core Breaker

All Canton Pneumatic Tools are guaranteed against defects for a year—they are ***"guaranteed good"*** tools.

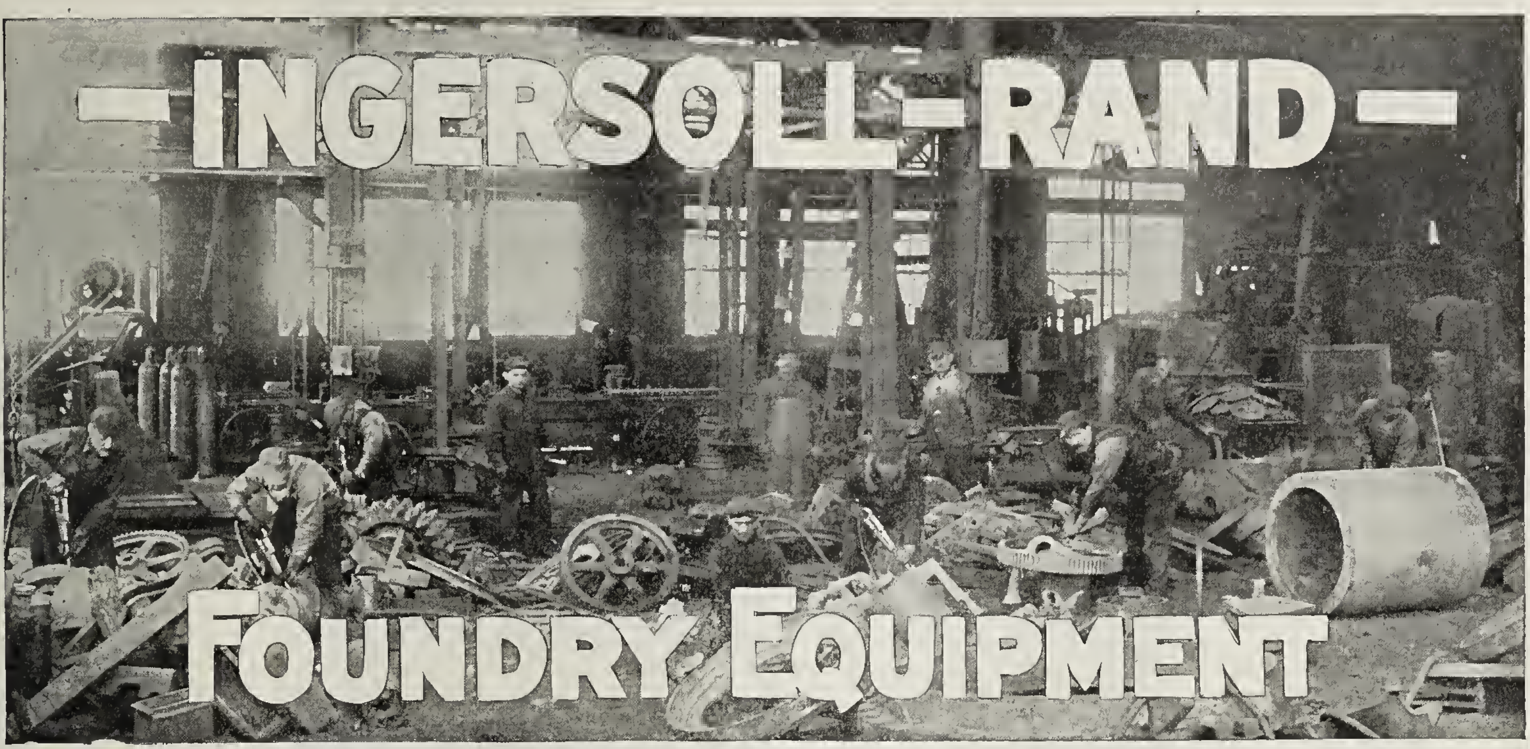
On account of their strength and durability, they are especially qualified for foundry work.

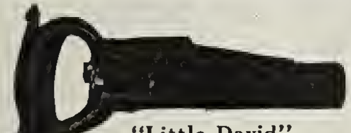
The small number of parts used in their construction reduces their maintenance cost to a minimum.

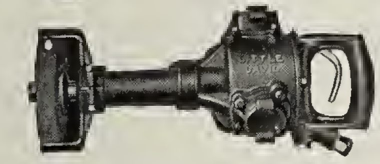
Continued repeat orders from many of the largest foundries in the country speak for their efficiency.

Choose the type of tool you require and let us send it to you on 10 days free trial.

THE PITTSBURG PNEUMATIC CO.
CANTON, OHIO




"Little David"
Chippers


"Little David"
Grinders

"Crown"
Sand
Rammers

"Little David" Pneumatic Tools

Have earned the confidence of Foundrymen

They give the kind of service that's needed to-day—speed and reliability.

There's a tool for every need and each lives up to the "Little David" standard of satisfactory service.

The complete "Little David" Catalog describes them all. If you haven't a copy, you will want one.

"Ingersoll-Rogler" Compressors

Supply the air for the tools at least cost

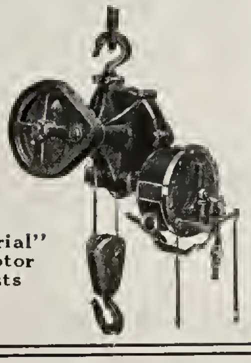
They need little attention, and when once installed can be depended on for week in week out service—24 hours per day if necessary.

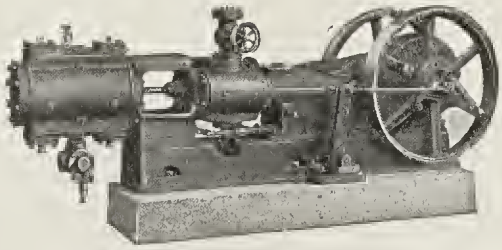
You can get one quickly—manufacturing facilities have been arranged for prompt shipment of urgent orders.

Ask for "Ingersoll-Rogler" Folder No. 869

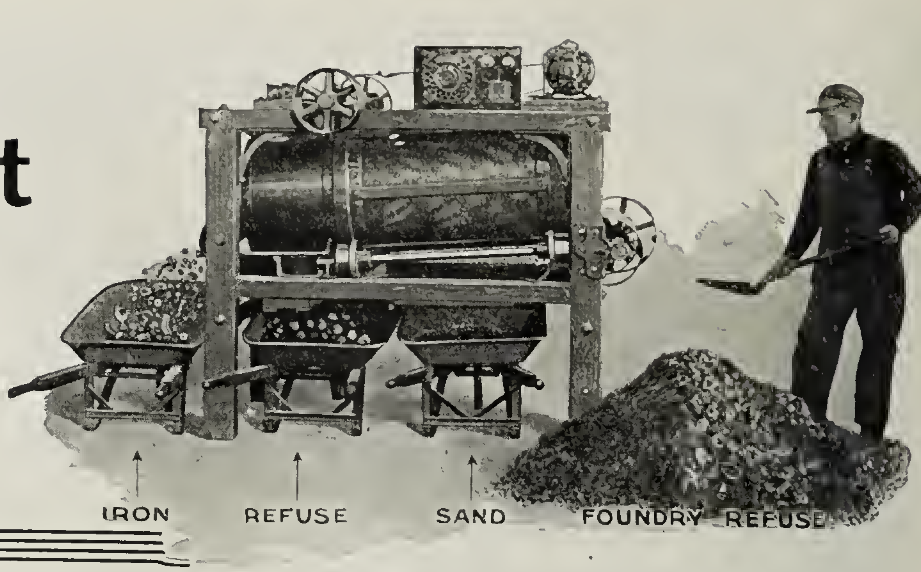
INGERSOLL-RAND COMPANY
11 Broadway, New York 165 Q. Victoria St., London
Offices the World Over

127-M


"Imperial"
Air Motor
Hoists


Ingersoll-Rogler Class ER-Steam Driven

If you can't fight, save



Patriotism can be shown by economizing as well as by fighting.

DINGS Magnetic Separator

Great forces of citizens are being recruited to fight ***waste*** and ***extravagance*** at home.

If you can't belong to the regulars, join the home guard. Help catch the thief that steals over a billion a year from Uncle Sam's hip pocket.

American Foundries are his favorite hang-outs.

Install a Dings Magnetic Separator and keep your most valuable metal from his clutches.

Dings Magnetic Separator will recover thousands of dollars worth of material for you that otherwise would go to waste. It quickly and thoroughly separates the valuable from the worthless.

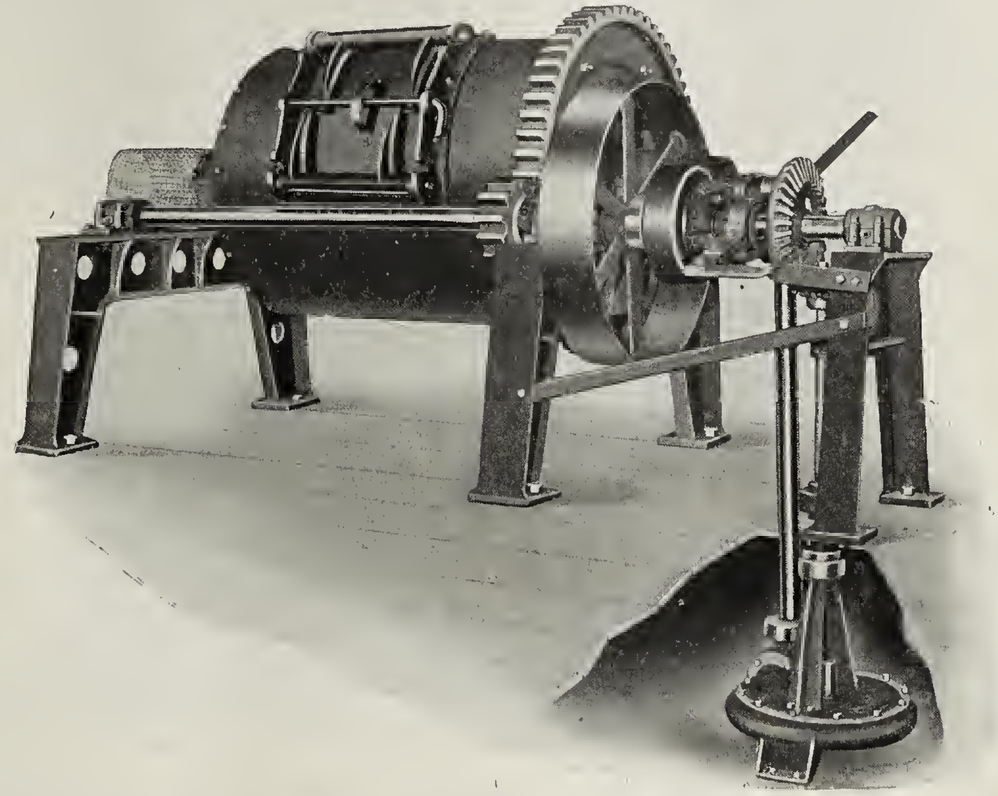
Dings Magnetic Separator is built for use in iron foundries and many other kinds of industrial plants.

Write at once for complete description. Over 2000 are now in daily use.

Dings Magnetic Separator Co.

MILWAUKEE 675 Smith Street WISCONSIN

Superior
Improved Iron Cinder Mill



Saves 95 per cent of the iron and 75 per cent of the coke contained in your cupola dump and gangway scrapings. Grinds the cinders and separates the coke and iron from the dirt in one operation.

SPECIAL FEATURES:

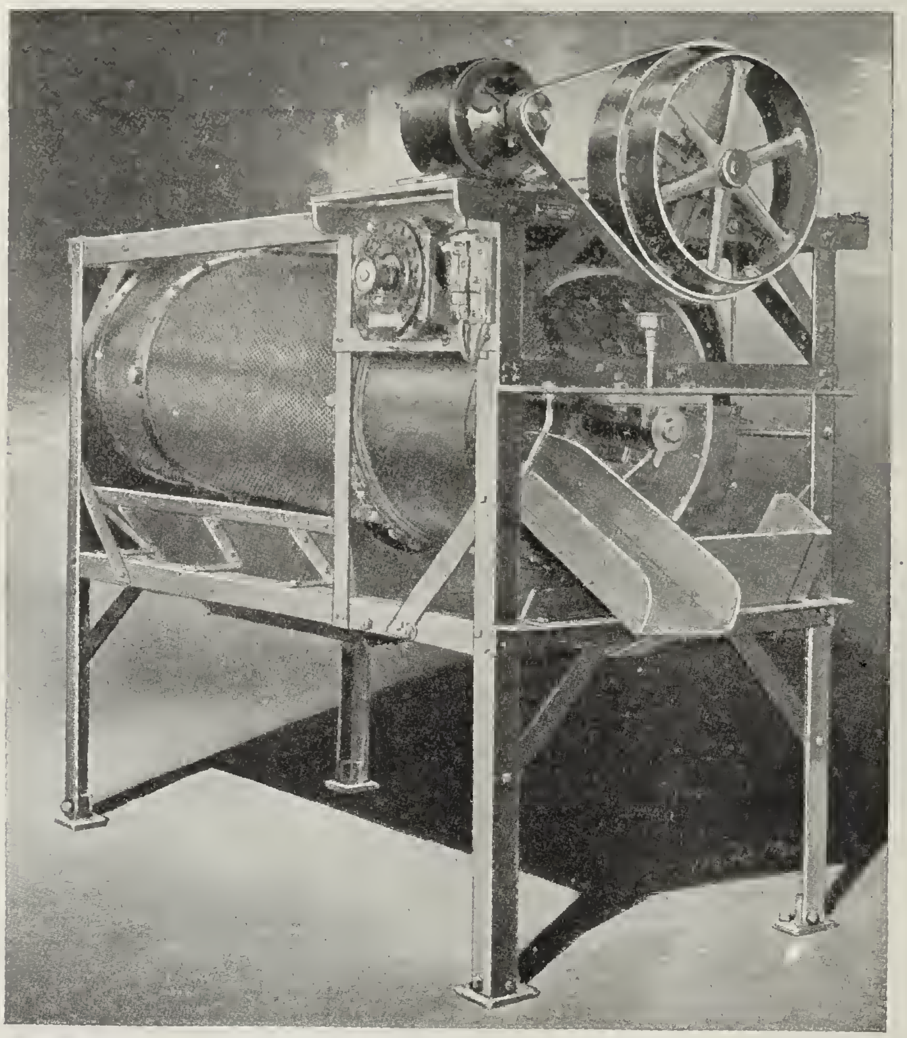
Journals made separate from head of mill.

Crusher can be removed through door, it not being necessary to take mill apart.

Write for Catalogue

Steel Exhaust Tumbling Mills, Water Tumbling Mills, Cinder Mills, Dust Arresters and Hard Iron Stars.

CLEVELAND NICKEL WORKS
CLEVELAND, OHIO



TYPE F MAGNETIC SEPARATOR WITH GENERATOR

SAVE METAL

By using M-M-C Magnetic Separators

Our type F Magnetic Separator is built especially for iron and steel foundry use. We claim for this machine Simplicity, Efficiency and Durability. There are no friction wheels, friction rings, bevel gears or superfluous bearings or shaftings on this Separator; hence, less cost to maintain. There are only four bearings on the machine.

The moving parts are operated from a small countershaft by means of a standard chain belt; the foundry refuse or mixed material is shoveled in at one end of the machine; the sand is sifted out while passing through a revolving screen. The iron and steel are attracted by magnetic lines of force to the inside surface of the revolving cylinder and are carried up and automatically discharged into a spout which deflects it to the discharge end of the machine while the coke, slag and other non-magnetic materials discharge from the lower end of the cylinder.

The three products of this machine may be received in wheelbarrows if so desired, thus saving labor in handling.

The frame is made of steel, there being no wood parts to our type F machine.

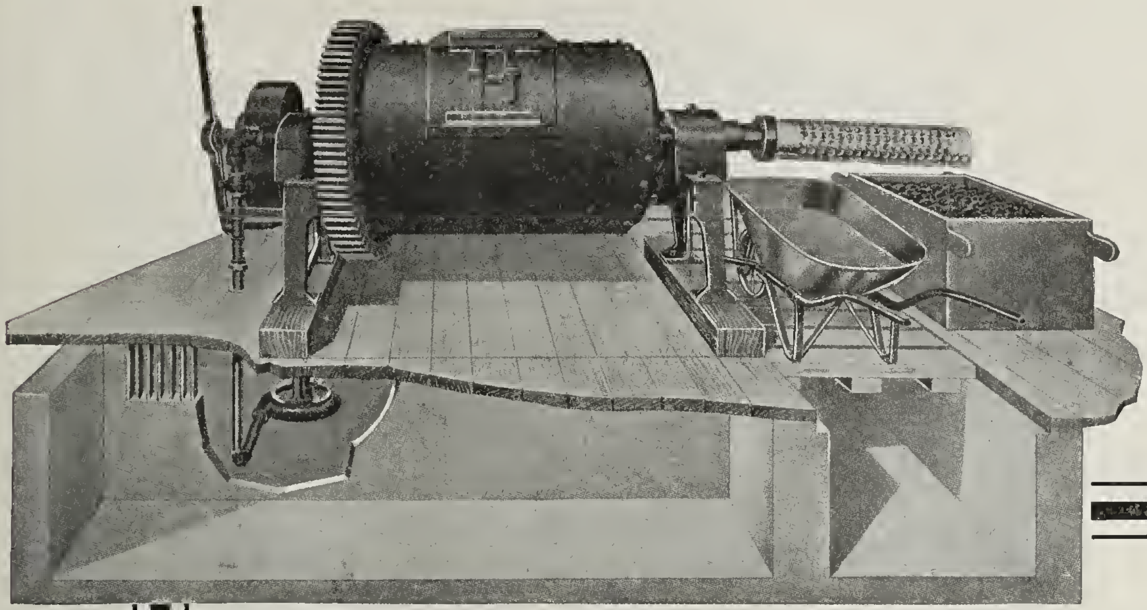
It was designed by Alvin Dings and is one of our latest products. We stand back of them in every respect. We ship them on approval and allow you to try them out at your own works.

Write for prices and particulars

MAGNETIC MFG. CO.

610 Enterprise Bldg. MILWAUKEE, WIS.

Save
your
Iron
and
Coke



The ILLINOIS Improved Water Cinder Mill

will recover fully 95 per cent of the iron from your cupola cinders and gangway cleanings, and about 80 per cent of the coke from the cinders. This coke can be used successfully in the cupola or for the coke ovens.

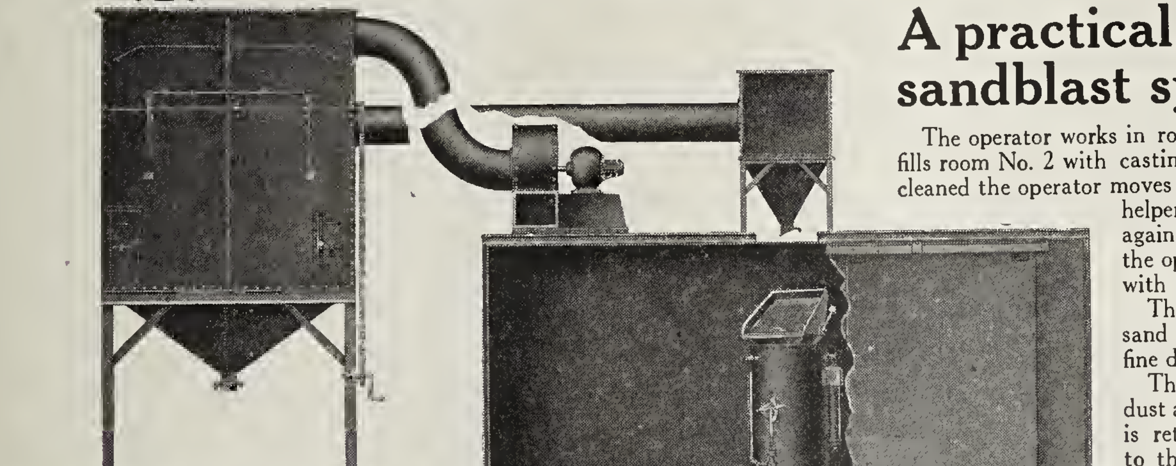
The mill is furnished complete with friction clutch pulley and centrifugal pump. It is installed on a tank constructed of either brick or concrete. This tank is divided into three compartments, the first directly under the mill contains the water in which the pump is set; the second the settling basin; and the third for the refuse matter.

Tank and foundation are furnished by the purchaser, as per plans furnished with the mill.

During the operation of the water mill, the cinders are crushed by means of a crusher which revolves within the body of the mill when in operation. The water pumped up through the mill by the centrifugal pump separates the iron from the cinders and coke. The cinders and coke are carried out of the mill through the hollow trunnion. The separating heads prevent the iron from passing through with the refuse matter—the iron remains within the mill and after being cleaned is discharged through the door opening. The screen attached to the trunnion carries the coke over the refuse tank into the box, as illustrated. By using the tanks and the centrifugal pump, as explained, the water is used over and over again.

The ILLINOIS Double Sandblast Room

A practical continuous sandblast system



The operator works in room No. 1, while his helper fills room No. 2 with castings. When the castings are cleaned the operator moves into room No. 2 while his helper removes the castings and again fills room No. 1. This keeps the operator continually supplied with work.

The Illinois System elevates sand by suction and separates the fine dust from the sharp sand.

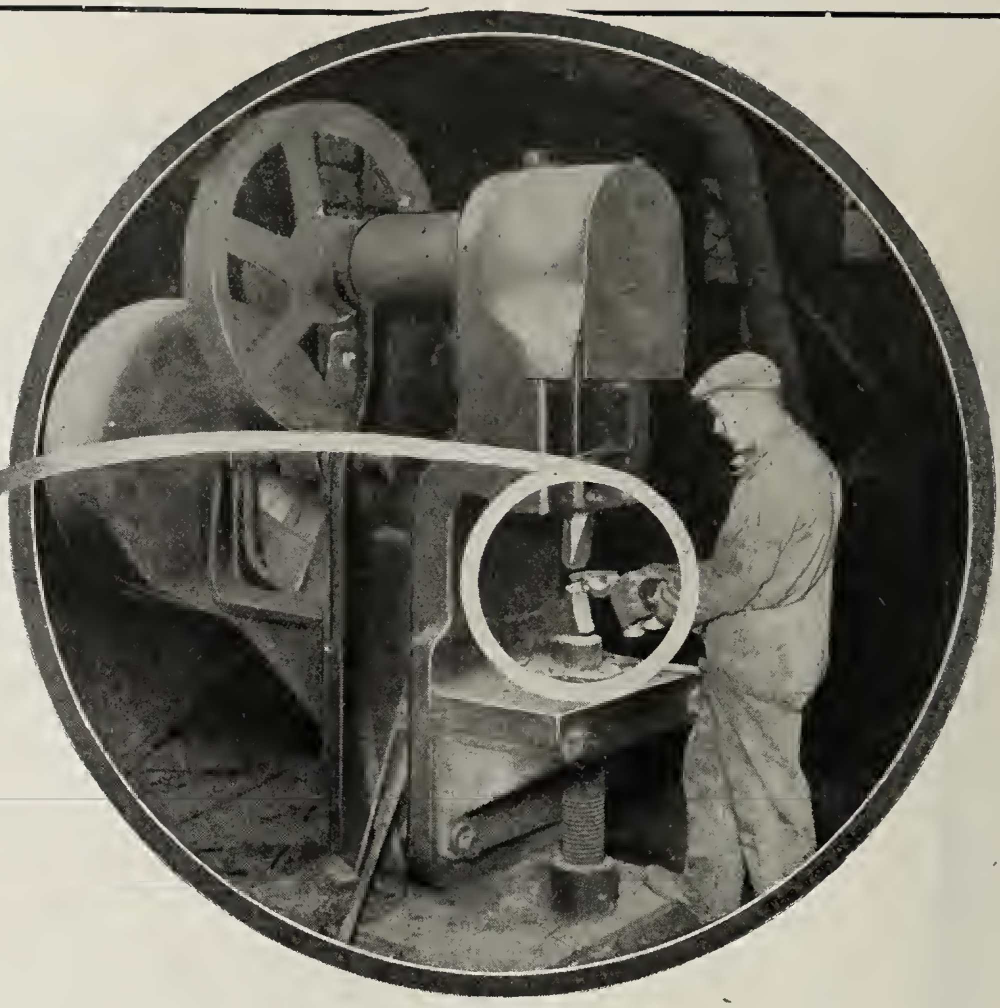
The dust is taken care of by the dust arrester, while the sharp sand is returned from the separator to the sand blast machine. The air is changed in the room from five to seven times per minute.

Save the time of your high priced operator by installing the Illinois Double Sand Blast Room in your foundry.

We also manufacture Exhaust Tumbling Mills, Dust Arresters and the Combination Brass Water Cinder Mill and Casting Tumbler.

ILLINOIS MANUFACTURING & SUPPLY CO.
Quincy, Illinois

The Milwaukee Sprue Cutter in Action



Mr. Foundryman!!

Do you realize that you do not have to knock off sprues with a hammer or chip them off with a cold chisel? Years ago the old method was all right—you did not have a better way of doing it. That time has now passed. Hammers and chisels do a bungling job and break castings, but the "Milwaukee" cuts them quickly and clean.

The "Milwaukee" not only cuts "Risers", but cuts "Rising costs".

Built extra heavy, it cuts gates and runners as large as 1¾" square or 2" round. It also does extra good work in cutting fins from steel or bronze castings. One man with a "Milwaukee" does the work of six men without it—a big cost saver.

Vulcan Engineering Sales Company
1759 Elston Avenue Chicago, U. S. A.

Sales Agent for

Hanna Engineering Works
The Q M S Co.
Mumford Molding Machine Company
J. C. Busch Co.

COLEMAN CORE OVENS produce the results you are after —rapid baking, low core-breakage and low cost of operation.

Built-to-Order Core Oven Equipment

COLEMAN CORE OVENS are not stock ovens. Each installation is designed and *guaranteed* to meet the customer's individual requirements. In order to handle your core-baking most economically your ovens must be suitable for your work. Our engineering department with twelve years experience in the science of core oven building is ready to co-operate with you.

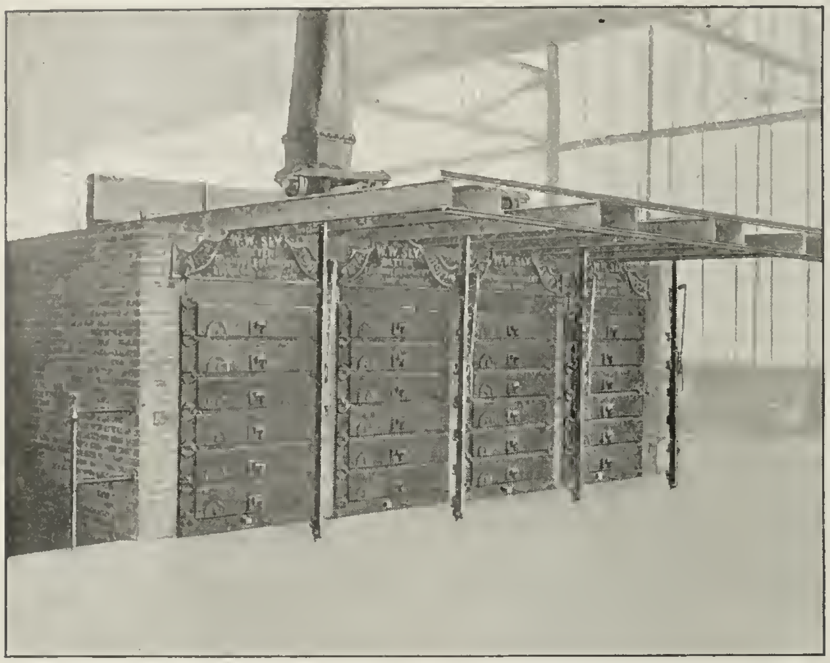
COLEMAN CORE OVENS are built in any combination of rolling drawers, shelves, cars or portable racks. Coke, oil or gas fired.

WRITE FOR BULLETIN

A built-to-order combination battery of Coleman Rolling Drawer and Coleman Car-Type Core Ovens, at the OTIS STEEL COMPANY, CLEVELAND, OHIO.

THE FOUNDRY EQUIPMENT CO.
FOUNDRY ENGINEERS

1831 Columbus Road CLEVELAND, OHIO



Installed at New Plant of Cleveland Co-Operative Stove Co.

THE SLY

BET

FOUNDRY

Drawer Type Core Ove

Drawer Heights can be changed to meet every size of core without cutting or drilling. ¶ Elimination of waste space saves fuel and brings top drawer within easy reach of operator. ¶ Simple arrangement of flues and dampers means even distribution of heat, thorough baking of cores, low fuel consumption. ¶ No warping. ¶ Coke, Gas, or Oil Firing.

Car and Rack Ovens—Core Cars and Core Racks

Why Throw Away Core Sand?

Core Sand Reclaimer

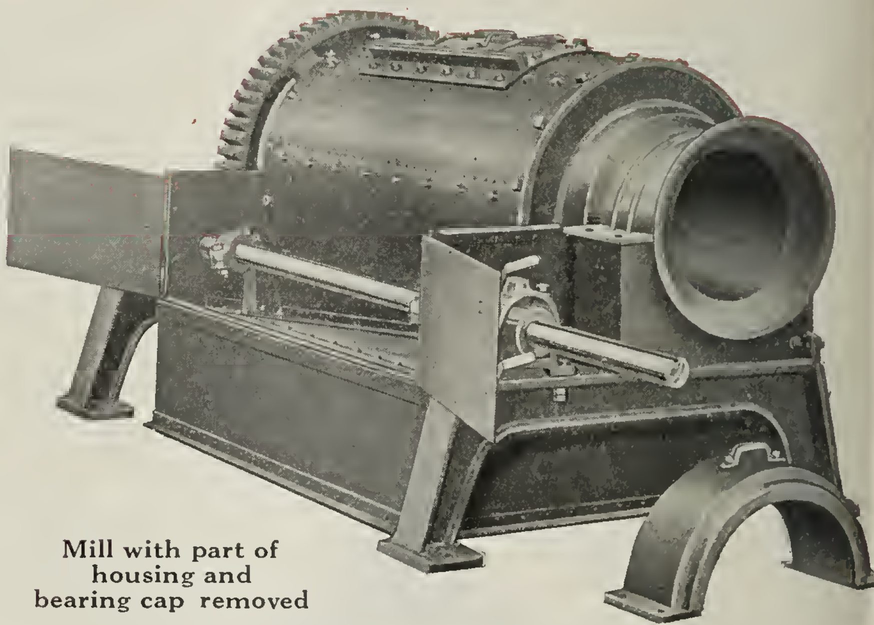
Patent Applied For

Reclaim 60% by our Continuous Automatic Process

Simply shovel the old cores into large opening of crusher.

The cores are broken up, the burned sand and dust exhausted, the nails, wires and other foreign matter are screened, thus leaving clean sand, which with a small percentage of binder added, makes same ready for re-use, as good as originally.

This machine pays for itself in a very short time.



Mill with part of housing and bearing cap removed

Read What the Stroh Castings Co. Say About This Machine.

"We are pleased to tell you that the core crushing machine in conjunction with your suction elevating device and your automatic sand separator in which the dust is thoroughly separated from the sand, has been in successful operation for the past six months. The good sand is automatically discharged in the storage bin which is used up daily.

We have experienced no difficulty with this machine since its installation, and we therefore can recommend its usefulness to any one contemplating a purchase. Yours truly, ***Stroh Castings Co.,*** Detroit, Mich."

Eastern Representative
H. P. FURLONG, 285 EASTERN PARKWAY
BROOKLYN, NEW YORK

THE W. W. SL

CLEVELAND

LINE OF
TER
EQUIPMENT

omplete Cleaning Mill Installations

Shells are made of special steel, giving exceptionally long life. Interior lined with steel, thus protecting cast iron parts from wear.

Gears are made of Semi-Steel, especially designed teeth, wide face and tested to a 3600 lb. breaking strain.

Bearings are of Chilled Iron, and fully protected from dust.

Every part of the Mill is constructed for durability and efficient Cleaning.

Made in every practical size and shape.

Let our Foundry Engineers suggest a better cleaning outfit for you.

Write for our complete catalog

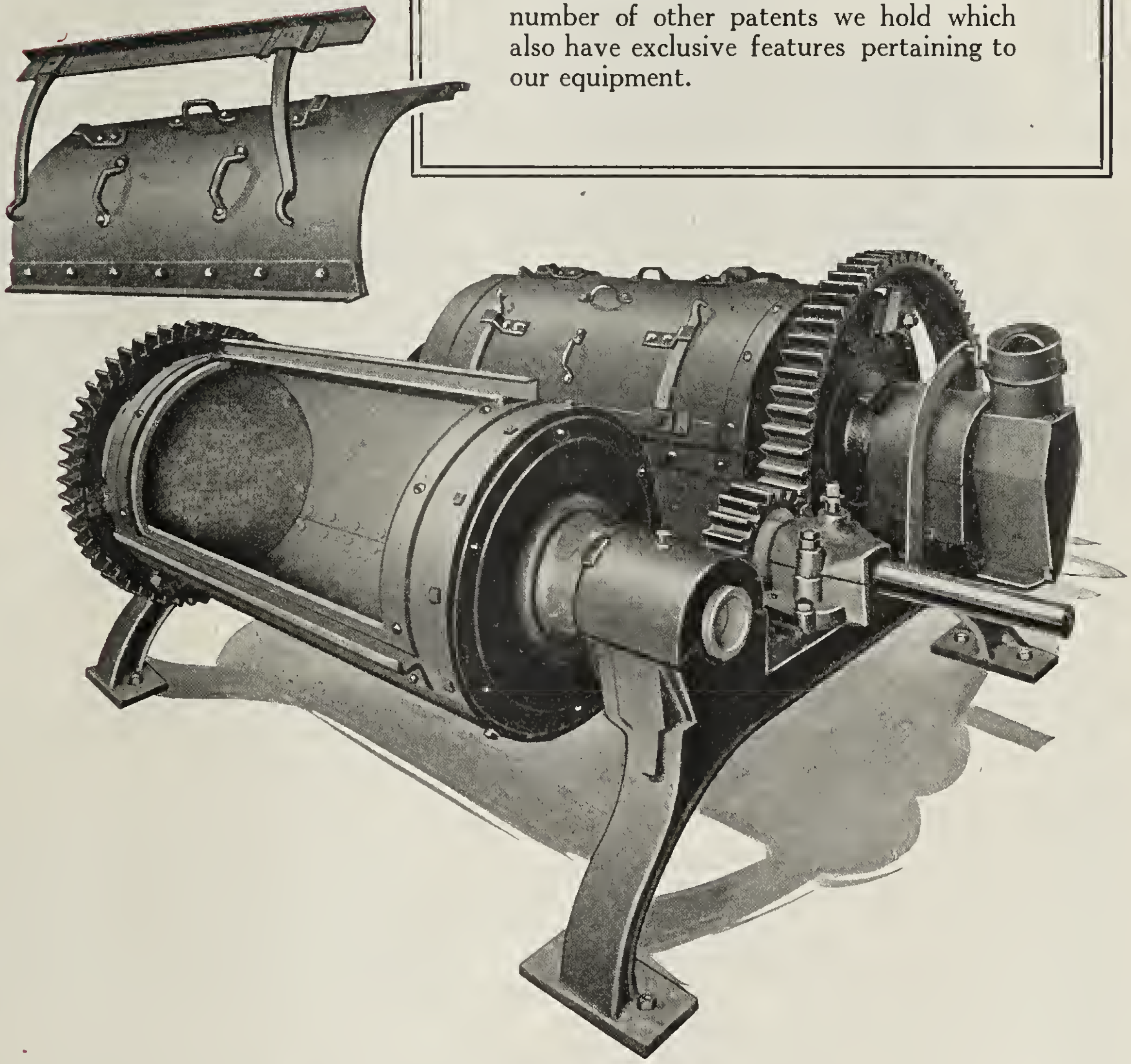
Your First Order means Perpetual Patronage

Clean Castings and a Clean Mill Room

By Using the Sly Exhaust Mills

**Note our Patented Door Fastener—
Easy to operate and secure.**

This is a One-man Fastener used on the doors of our Cinder and Tumbling Mills, which is protected by our Patent No. 703,313, issued June 24, 1902. After litigation in the Courts, extending over a number of years and expending over $25,000 in attorney and court fees, this patent has been held to be valid by the U. S. Circuit Court of Appeals for the Seventh Circuit (the Court of last resort in patent matters). This exclusive Sly feature is applied to all of our Cinder and Tumbling Mills, and we are prepared to protect ourselves, and our customers in the exclusive use of above as well as a number of other patents we hold which also have exclusive features pertaining to our equipment.



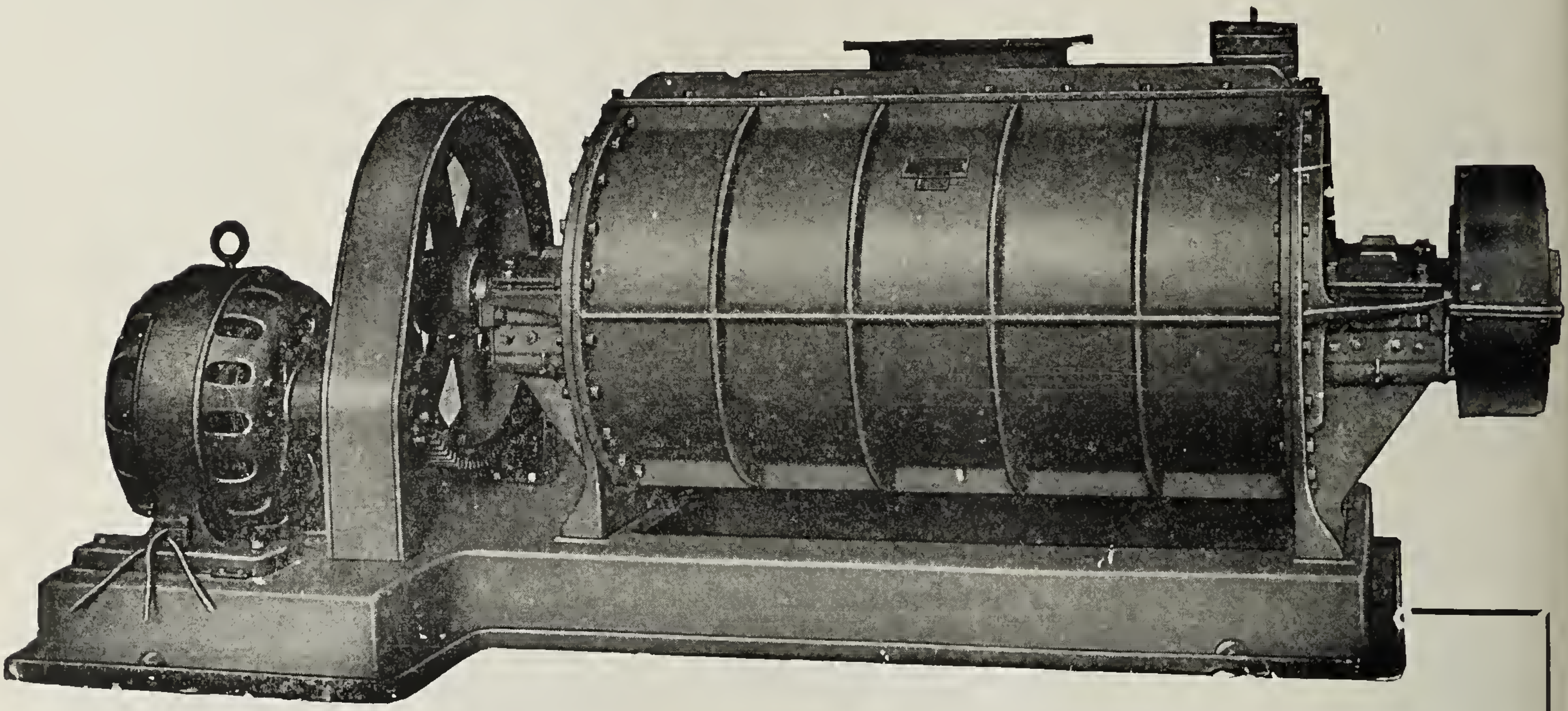
IFG. COMPANY
HIO

Western Representative
P. W. GRAUE 4033 NORTH LAWLER AVE.
CHICAGO

ROOTS

At the suggestion of THE FOUNDRY we have taken this page advertisement, because under present circumstances it is almost impossible to secure material for the insert that we have been using for over twenty years

Later on we expect to return to the insert advertisement.



Accurate Results Every Time!

Accurate results in Cupola work are absolutely essential. Too little air means sluggish iron and low efficiency of Cupola. Too much air means oxidation, dull iron and blow holes.

Roots Positive Pressure Blowers produce accurate results every time. They allow you to blow the exact quantity of air required for your mixture.

Ask us to send you our interesting Catalog No. 58, which contains a complete description of our blowers, as well as much useful knowledge on air distribution.

P. H. & F. M. ROOTS COMPANY

NEW YORK
120-122 Liberty St.

CONNERSVILLE, INDIANA

CHICAGO
Peoples Gas Bldg.

Co-Operative Engineering Co. Inc.

The
LOGICAL CONCERN
to give
MACHINE WORK

BECAUSE
With their ASSOCIATED MACHINE SHOPS
AND
THOUSANDS OF MACHINE TOOLS
THOUSANDS OF SKILLED MECHANICS
AND

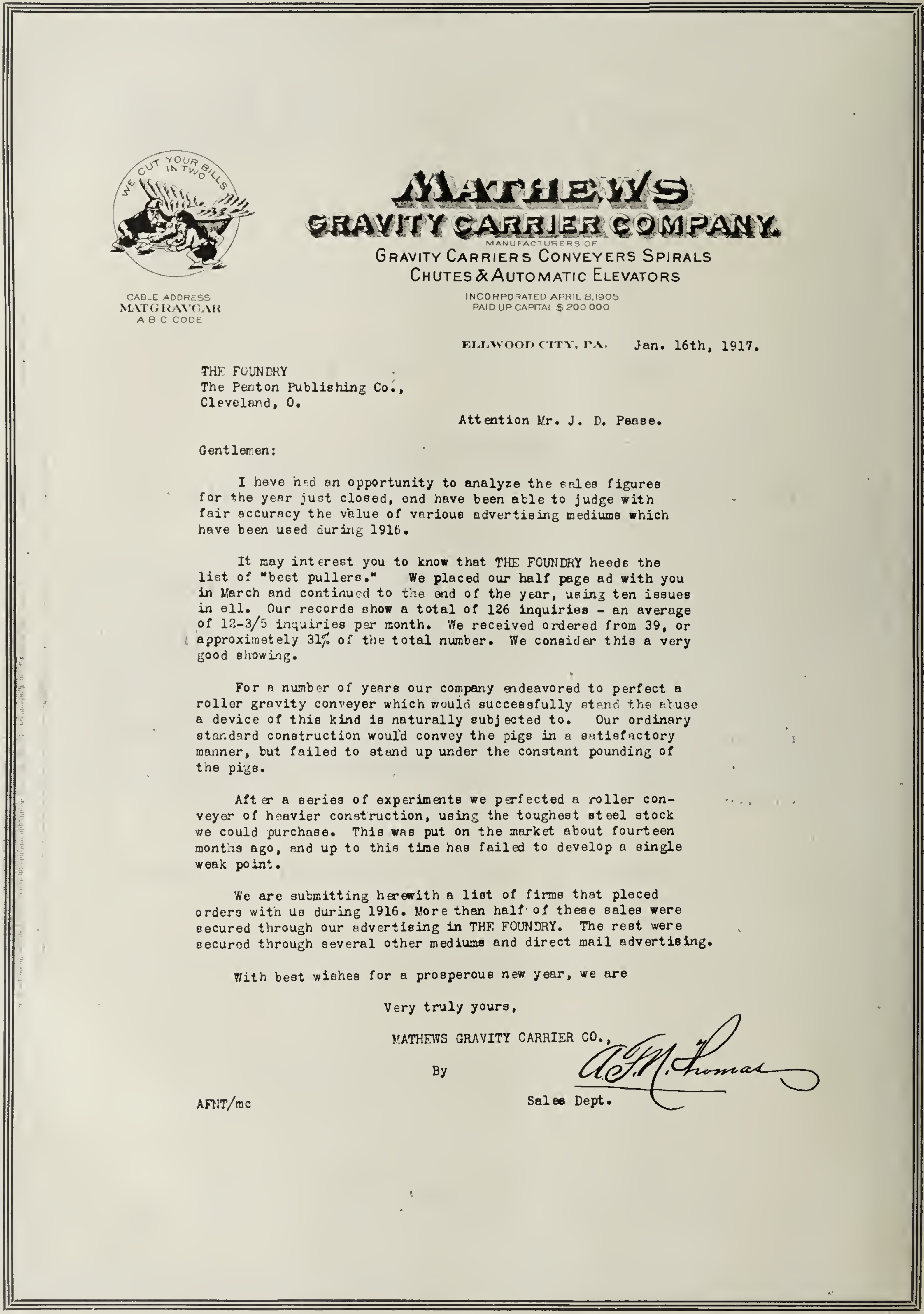
the necessary complement of MANAGERS, ENGINEERS, DESIGNERS, and DRAFTSMEN—GUARANTEES EFFICIENCY, ECONOMY, and DELIVERY.

MACHINE SHOPS located in ALL parts of the United States

Send US your SPECIFICATIONS, SAMPLES or BLUE PRINTS.

Prompt Attention Guaranteed

50 Church Street, New York



WE CUT YOUR BILLS IN TWO

MATHEWS
GRAVITY CARRIER COMPANY.
MANUFACTURERS OF
GRAVITY CARRIERS CONVEYERS SPIRALS
CHUTES & AUTOMATIC ELEVATORS

CABLE ADDRESS
MATGRAVCAR
A B C CODE

INCORPORATED APRIL 8, 1905
PAID UP CAPITAL $ 200.000

ELLWOOD CITY, PA. Jan. 16th, 1917.

THE FOUNDRY
The Penton Publishing Co.,
Cleveland, O.

Attention Mr. J. D. Pease.

Gentlemen:

I have had an opportunity to analyze the sales figures for the year just closed, and have been able to judge with fair accuracy the value of various advertising mediums which have been used during 1916.

It may interest you to know that THE FOUNDRY heads the list of "best pullers." We placed our half page ad with you in March and continued to the end of the year, using ten issues in all. Our records show a total of 126 inquiries - an average of 12-3/5 inquiries per month. We received ordered from 39, or approximately 31% of the total number. We consider this a very good showing.

For a number of years our company endeavored to perfect a roller gravity conveyer which would successfully stand the abuse a device of this kind is naturally subjected to. Our ordinary standard construction would convey the pigs in a satisfactory manner, but failed to stand up under the constant pounding of the pigs.

After a series of experiments we perfected a roller conveyer of heavier construction, using the toughest steel stock we could purchase. This was put on the market about fourteen months ago, and up to this time has failed to develop a single weak point.

We are submitting herewith a list of firms that placed orders with us during 1916. More than half of these sales were secured through our advertising in THE FOUNDRY. The rest were secured through several other mediums and direct mail advertising.

With best wishes for a prosperous new year, we are

Very truly yours,

MATHEWS GRAVITY CARRIER CO.,

By A. F. M. Thomas

AFNT/mc Sales Dept.

Our Waterbury Plant which is producing over two million pounds of Briquet-Ingots per month

Brass Scrap Conversion Service

A simple solution of the problem of putting brass chips and other finely divided brass scrap to useful use.

You ship this waste to us in barrels, bags, boxes —*any* way.

We put it through unique purification processes that remove the iron and other foreign substances. Then we *impact* the purified chips into

Briquet-Ingots

These ingots are returned to you along with any heavy melting scrap, free iron and other non-briquettable material your shipment contained.

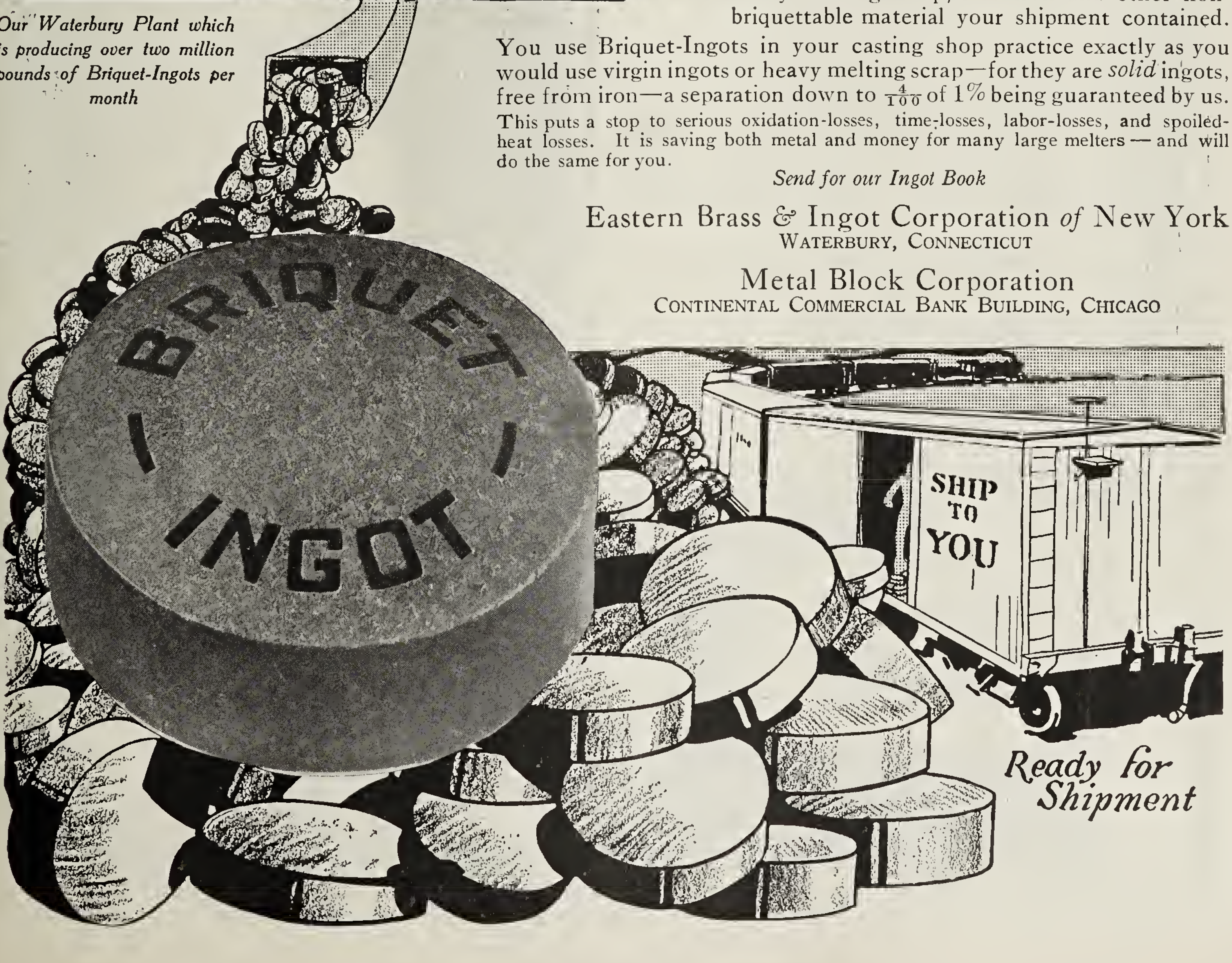
You use Briquet-Ingots in your casting shop practice exactly as you would use virgin ingots or heavy melting scrap—for they are *solid* ingots, free from iron—a separation down to $\frac{4}{100}$ of 1% being guaranteed by us.

This puts a stop to serious oxidation-losses, time-losses, labor-losses, and spoiled-heat losses. It is saving both metal and money for many large melters — and will do the same for you.

Send for our Ingot Book

Eastern Brass & Ingot Corporation *of* New York
WATERBURY, CONNECTICUT

Metal Block Corporation
CONTINENTAL COMMERCIAL BANK BUILDING, CHICAGO



Oxweld Service Men Know

The expert operators of our service department have inside knowledge of the work that has been done in our great welding shops and laboratories.

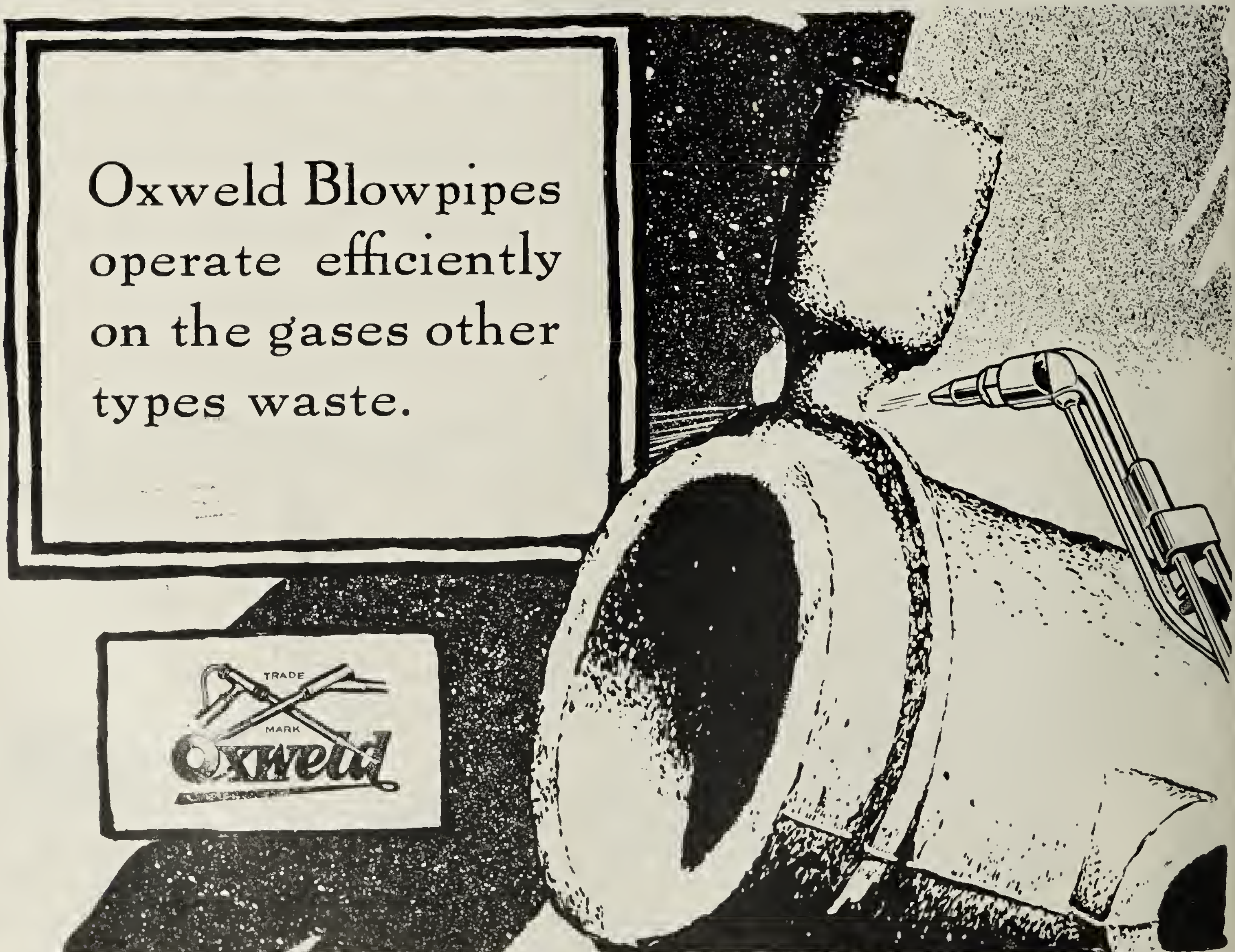
They are familiar with all the factors in the successful handling of the thousands of welding and cutting jobs brought up to date.

We solicit an opportunity to demonstrate the value of the service which this staff of specialists are rendering to those entitled to it.

OXWELD ACETYLENE COMPANY

NEWARK, N. J. CHICAGO LOS ANGELES

World's largest makers of Oxy-Acetylene Apparatus and Supplies

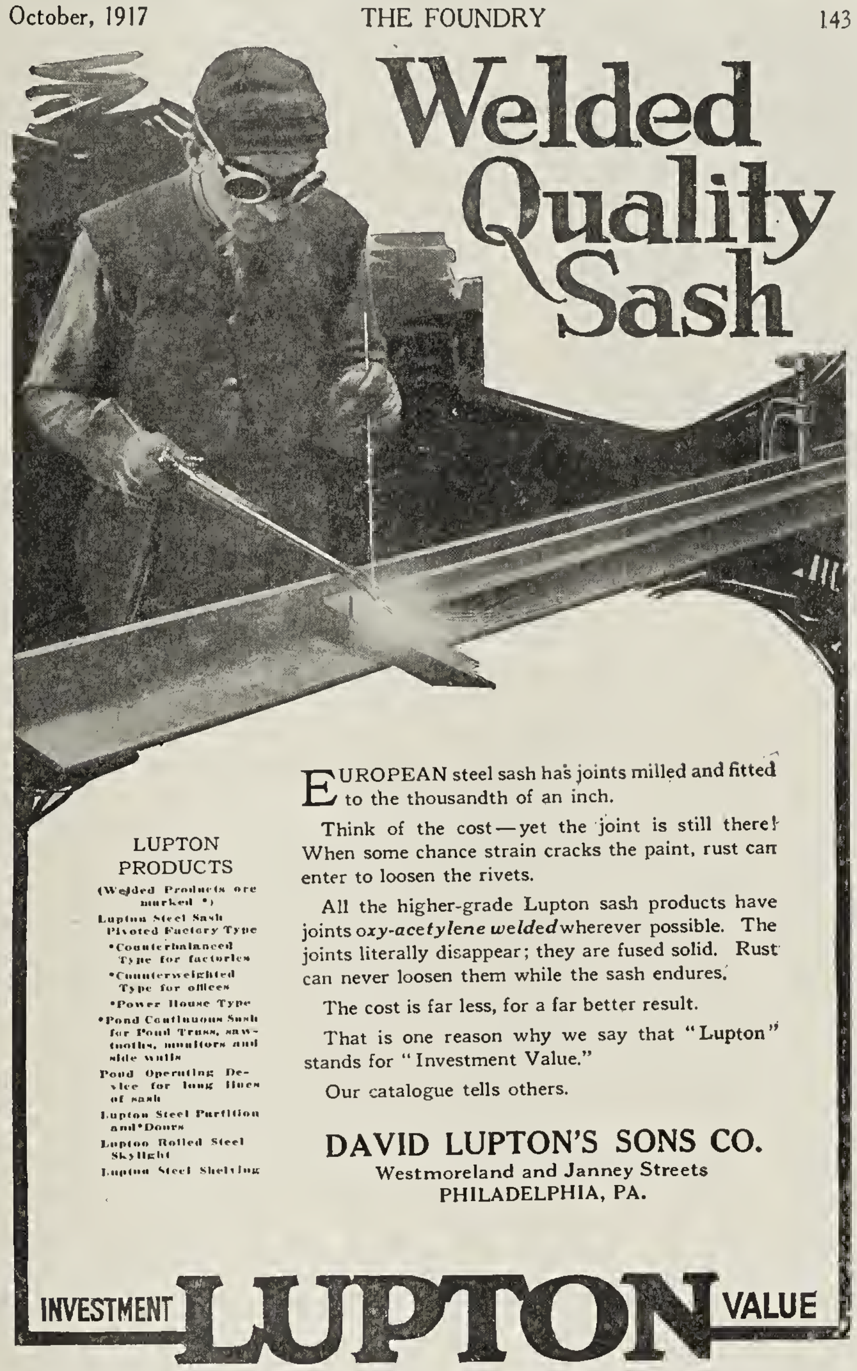

Oxweld Blowpipes operate efficiently on the gases other types waste.
TRADE
MARK
Oxweld

One of the Prominent Users of Davis-Bournonville Apparatus

David Lupton's Sons Company advertise the efficiency of their welded products. They say, "all the high grade Lupton sash products have joints ***oxy-acetylene welded"***—and we add—***"with Davis-Bournonville welding apparatus."*** They have an extensive acetylene pressure generating system, piped throughout the plant, a very large number of welding units, and for many years have been among the most successful users of the Oxy-Acetylene Welding Process.

There is more Davis-Bournonville Apparatus in successful use for Oxy-Acetylene Welding and Cutting by the largest metal-working concerns in the United States than of any other make, because it offers the widest range of equipment and application, highest efficiency, and is backed by the longest experience in manufacture, development, and practical use.

"Davis Apparatus" is used in manufacturing, reclamation and repair work by the leading foundries, steel mills, shipbuilding yards, navy yards, locomotive and car builders, auto and truck makers, sheet-metal workers, general repair shops, ***and by the U. S. Army and Navy at home and abroad.***



October, 1917 THE FOUNDRY 143

Welded Quality Sash

LUPTON PRODUCTS

(Welded Products are marked *)

Lupton Steel Sash
  Pivoted Factory Type
  *Counterbalanced Type for factories
  *Counterweighted Type for offices
  *Power House Type
*Pond Continuous Sash for Pond Truss, saw-tooths, monitors and side walls
Pond Operating Device for long lines of sash
Lupton Steel Partition and *Doors
Lupton Rolled Steel Skylight
Lupton Steel Shelving

EUROPEAN steel sash has joints milled and fitted to the thousandth of an inch.

Think of the cost—yet the joint is still there! When some chance strain cracks the paint, rust can enter to loosen the rivets.

All the higher-grade Lupton sash products have joints *oxy-acetylene welded* wherever possible. The joints literally disappear; they are fused solid. Rust can never loosen them while the sash endures.

The cost is far less, for a far better result.

That is one reason why we say that "Lupton" stands for "Investment Value."

Our catalogue tells others.

DAVID LUPTON'S SONS CO.
Westmoreland and Janney Streets
PHILADELPHIA, PA.

INVESTMENT LUPTON VALUE

A Lupton advertisement in Trade Publications.
Reproduced with Their Permission.

Davis-Bournonville Company

Oxy-Acetylene Welding and Cutting Apparatus

General Offices—Jersey City, N. J.
Factories—Jersey City, Elkhart, Ind., Niagara Falls, Ontario

New York
Boston
Philadelphia

Pittsburgh
Cleveland
Cincinnati

OXY-ACETYLENE WELDING
DAVIS
APPARATUS
DAVIS-BOURNONVILLE CO. N.Y.

Chicago
Detroit
St. Louis

Seattle
San Francisco
Los Angeles

The Truer The Man, The Better The Work Inside The Foundry.

No Place for Slackers.

C. M. Miller

The ***C. M. Miller Fluxes*** you've heard so much about
Are used by progressive Foundries and their praises they do shout.
We've ***Keystone Thermo Flux for Iron, Steel and Semi-Steels***
And ***Tungsten brand of Ladle Flux for chilled rolls and car wheels.***

Our ***Radioclarite for Brass, Bronze and non-ferrous metal***
Gives such quality and cleanliness, there's no dispute to settle.
And if it's ***solid Copper*** you've been trying hard to get
Our ***Special Radioclarite*** try and your troubles you'll forget.

It makes it solid every time and makes you feel so fine
You'll want to know what else we have to offer in the line.
To our ***Pearlite for Aluminum*** we'll next call your attention,
The success of which has been so great, we're surely glad to mention.

But when a thing's successful, as you very well know,
There's always someone who has "something just as good to show".
But don't you listen to such yarns so glibly learned by heart
But send direct for ***Alloy Flux*** that always hits the mark.

The ***C. M. Miller Fluxes*** have ***C. M.***'s personal supervision
And the dollar mark is not the mark that's printed on his vision.
He's interested in the foundries, and the work that they produce
And so from years' experience and study put to use.
He's manufactured the Fluxes which do away with "excuse".

The Fluxes are not over-rated; they give results every time
So now that you are interested, won't you drop us a line?
We assure you you'll not regret it—you'll save dollars where we make cents
As the fluxes are a saving and not an additional expense.

We've never had a law-suit, for you know, "The right will prevail".
So send us your inquiries and we'll answer quick by mail.
Send for our booklet and treatise, or 'twould be better, if you could
To send today for the Fluxes that make the Castings good.—H. M. N.

A great tribute paid to our Fluxes in these war times is the fact that the United States Government, the Allies and practically all the loyal people of this country are using them. "It's what's behind the guns that counts".

The Basic Mineral Company, Box 276, N. S. Pittsburgh, Pa.

TITANIUM TALKS

No. 13

One of our good customers, who uses one or two cars of Ferro-Carbon-Titanium per month, recently changed open hearth superintendents. The new man came from a large corporation, where he had been told that the use of Titanium increased segregation. They gave him his way. He cut out the Titanium. The quality of their steel immediately became inferior.

Ferro-Carbon-Titanium was again used, and now the new open hearth superintendent is as staunch an advocate of its use as his predecessor—who, by the way, went to another plant, and, of course, introduced Titanium there.

The Titanium Alloy Mfg. Company

Niagara Falls,
Pittsburgh Office: Oliver Building
New York Office: 165 Broadway

TPC
Reg. U. S. Pat. Off.
TRADE MARK.

New York
Chicago Office: Peoples Gas Building
Buffalo Office: Marine Bank Building

Agents for Great Britain and Europe: T. Rowlands & Co., Ltd., Sheffield, Eng.

How Boronic Products Saved A Firm From Going Out of Business

TO THE MAN OF THE MELTING POT:

Some days since we received a letter from a MAN OF THE MELTING POT, who saved his Company from quitting business BECAUSE THEY WANTED TO DO THE VERY UNUSUAL THING OF CASTING BRASS ROD WITH THE SAME TENSILE AND ELONGATION AS OBTAINED BY ROLLING.

The Company had called in the EXPERTS (?) and AFTER WASTING A LOT OF MONEY ON THEM, decided to give their MAN OF THE MELTING POT a show.

Now this letter is not intended in the least to convey the impression that EXPERTS are not sometimes as capable as MEN OF THE MELTING POT, but it is frankly intended to say in good English that the EXPERT who knows it all (?) and who has all his knowledge from the text-book (?), does not begin to know what this MAN OF THE MELTING POT KNOWS. He knew enough to "prove all things and hold fast to that which is good" regardless of what is written.

This MAN OF THE MELTING POT had heard of and had tried out, on a small test, BORONIC PRODUCTS and he set about to save his Company and to prove to his employers that he could not only DO WHAT HE CLAIMED, BUT THAT BASED UPON HIS CONFIDENCE AND KNOWLEDGE IN BORONIC PRODUCTS, HE COULD GET GOOD BUSINESS FOR THEM.

He writes that "until recently, they would take the advice of every Tom, Dick and Harry that came along and would think nothing of paying a large sum to so-called experts who would come along and guarantee to set them right without inquiring about the trouble." * * * * * *

"To-day I am making rod with your No. 7, which has a tensile strength of 63,000 pounds average and 35% elong. average and this is cast rod only,—not drawn or scalped or worked in any way, and I challenge any man to-day to accomplish the same results without the use of your alloy, or one equally as good, if such a thing is possible." * * * * * * * *

"Had it not been possible to obtain the results I have with the use of your No. 7, they simply could not and would not have been able to obtain the good business they now have for approximately 500,000 lbs. of brass forgings to be made from brass rod, unless, of course they could have spent thousands of dollars to first install a standard rod rolling and drawing mill." * * * * * *

"I want to be fair enough to distribute the credit to all who deserve it and surely the American Boron Products Co. deserves a portion."

"It is not only the brasses that I have been able to make records with, but bronzes, copper and aluminum castings."

MORAL:—MAN OF THE MELTING POT AND EXPERTS WHO HAVE THE HONEST INTEREST OF THEIR EMPLOYERS AT HEART, "GO AND DO LIKEWISE"!

It is no exaggeration to say that there are many MEN OF THE MELTING POT who are SUPPRESSED and HELD DOWN and WHO COULD MAKE GOOD FOR THEIR EMPLOYERS, IF THEY KNEW THAT THEY DARED OVER-RIDE THE INFELXIBLE LAWS LAID DOWN BY THOSE OVER THEM.

We are not minded to incite dissention and discord, but we invite the man who would like to HELP HIS EMPLOYER and those who would SHOW THE WAY TO FAIR-MINDED EXPERTS, TO CORRESPOND WITH US and LET US HELP THEM TO HELP THEIR EMPLOYERS TO BE PROGRESSIVE AND GROWINGLY HELPFUL TO THE WORLD'S UPLIFT.

Yours most firmly,

AMERICAN BORON PRODUCTS COMPANY, INC.

Sole Manufacturers of BORONIC PRODUCTS

FOREIGN DISTRIBUTORS:
Edward Le Bas & Co., London, E. C. 3, England
National Alloys Limited, London, England
China and Japan Trading Co., Ltd., Kobe Japan.
China and Japan Trading Co., Ltd., Shanghai, China.

Reference is requested to our list of products in the various preceding numbers of this publication.

To the Individual Mixer of Metals:

PLEASE USE THIS COUPON

American Boron Products Co., Inc., (F.-2)
Reading, Penna.

Gentlemen:—Kindly send me complete details regarding the many ways whereby I can economize by using Boronic Alloying Metals.

MY HOME ADDRESS IS:

Name ....

City ....

State ....

The Eyes of the Army

Throbbing on high, working steadily through torrents of shellfire, at times nearly red with the heat, the cylinders of the aeroplane motor must meet unflinchingly the long-continued stresses of battle.

It is doubtful if any mechanical contrivance is called upon for more exacting, fibre-destroying service than the aircraft in wartime. It is the eyes of the army and on the faithful performance of individual machines, thousands of brave, highly trained men risk their lives.

At the same time, every ounce of weight saved is precious. All this calls for a metal with real stamina. Weak, spongy castings weeping at every pore don't go.

That's why makers of aero motors are turning to *Our Charcoal Iron.* America expects to build a fleet of 25,000 airplanes in twelve months or less, and in this vast program of defense, *Our Charcoal Iron* will play a prominent part.

For the cylinder castings, a mixture of 20 per cent Hinkle, 40 per cent No. 1 Coke foundry, 30 per cent No. 1 medium machinery scrap (A. F. A. specifications) and 10 per cent soft steel will give good results. This formula has been used by a maker of high-speed, air-cooled motorcycle cylinders for several years and he has found it A-1. It's far superior to the all coke-iron mixtures some slick, know-it-all chemists try to get by with.

Real foundrymen know the value of charcoal iron.

Tie to Our Charcoal Iron—It Pays

Make your selections from the Big Four

Hinkle Champion Michigan Pine Lake

OUR CHARCOAL IRON

CHARCOAL IRON COMPANY OF AMERICA

DETROIT, U. S. A.

OUR CHARCOAL IRON

THE PRODUCTION OF MALLEABLE CASTINGS

By RICHARD MOLDENKE

The author of this practical and comprehensive treatise on malleable practice needs no introduction to the foundrymen of the world. As a specialist in malleable work his reputation needs no further comment.

A life's experience in this intricate branch of the foundry industry is written into this work. If you are interested in the manufacture or use of malleable iron you should have this book in your library.

CONTENTS

History, Early Development and Present Importance of the Malleable Iron Industry.
Characteristics of Malleable Cast Iron.
The Testing of Malleable Cast Iron.
The Pattern Shop of the Malleable Foundry.
Molding Methods in the Malleable Foundry.
Melting Processes.
The Construction and Operation of the Air Furnace.
The Construction and Operation of the Open-Hearth Furnace.
The Use of Gas Producers in Malleable Foundries.
Mixing the Charges for Malleable Iron.
Casting Malleable Iron.
Annealing Malleable Castings.
Characteristics of Malleable Furnaces.
Use of the Pyrometer in the Annealing Room.
Cost of Malleable Castings.

150 Pages, 35 Excellent Illustrations.

Price $3, Postpaid.

PENTON'S BOOK NEWS, CLEVELAND, OHIO

202

SMOOTH-ON SPECIALTIES FOR FOUNDRYMEN

Smooth-On Castings No. 4 meets every need of the Foundryman for repairing defects, blemishes, blow holes, etc. in Iron or Steel Castings.

Sold in two grades—Grade No. 4 "A" for the finer Castings and Grade No. 4 "B" for coarser and more unfinished Foundry work. Put up in 1, 5, 10 and 25 Pound compression top cans with *yellow* label as illustrated. All genuine Smooth-On cans bear the Smooth-On trade mark.

SMOOTH-ON CASTINGS

is a chemical iron compound, in powder form, that amalgamates with the iron forming part of the casting to which it is applied. It expands and contracts in the same ratio as the casting itself. Smooth-On fills all sand holes, air holes, surface defects and makes the casting perfect. A very few uses are:

1. Smoothing the surface of iron castings.
2. Stopping up sand holes.
3. Stopping up pores in spongy iron.
4. Covering up countersunk bolts.
5. Smoothing over "cold short" castings.
6 Stopping leaks of gasoline or oil.

WITH increasing costs in every department Foundrymen are interested just now in reducing the size of the scrap heap. Reduce your scrap heap and you save on the high cost of moulders labor, material and other overhead coming from the process of recasting.

The use of Smooth-On Castings increases your output, reduces the scrap heap and saves you money.

Smooth-On Casting is working daily in hundreds of foundries. It can work profitably for you!

Write today for the Smooth-On Instruction Book—it's free.

SMOOTH-ON MFG. CO.
Jersey City, N. J., U. S. A.
For Sale By All Foundry Supply Houses.

Two Valuable Books for Foundrymen

Instruction Book No. 16 with 144 pages of Iron cement data and our No. 7 book on water, dust and oil proofing concrete floors. One or both sent on request. Use the coupon.

FREE

SMOOTH-ON MFG. CO., Jersey City, N. J.
Gentlemen:—
Please send me a new copy of your
( ) Smooth-On Instruction Book No. 7.
( ) Smooth-On Instruction Book No. 16.
Name ....
Address ....

Forty years experience making the best Crucibles possible to make

UNIFORM

BEST MATERIALS

McCullough-Dalzell Crucible Co.

Pittsburgh,
Pa.

Excellent Results

Reported by Users of

BLACK CROSS

BRAND

CRUCIBLES

In Stock
No. 25, 30,
35, 40,
50, 60,
70, 80,
100, 125
150, 200
225

BLACK CROSS BRAND
DURABLE
RELIABLE

Prices
As Low
As Any
For
First-class
Crucibles

For Full Information Apply to

NEW CHICAGO CRUCIBLE CO.

2525 CLYBOURN AVENUE
CHICAGO, ILL.

Telephone: Lincoln 7400

MAXIMUM QUALITY—STEEL—MINIMUM COST

SNYDER ELECTRIC FURNACES

RAPID
SIMPLE
ECONOMICAL

SNYDER
SYSTEM

FOR EITHER
SINGLE OR THREE
PHASE OPERATION

INDUSTRIAL
ELECTRIC·FURNACE·COMPANY
53·W·JACKSON·BLVD: CHICAGO

The writer was 54 years young November 11, 1917, and 44 of these years were spent in the Foundry, as Apprentice, Molder, on to Manager, Systematizer and Foundry Adviser.

This experience covers the most wonderful period in the whole history of the iron and steel foundry business, and LOOKING BACK it seems but a FEW YEARS AGO, that the average foundry foreman was an ***honest, conservative, practical molder***—promoted from the sand-heap. BUT TODAY in addition to these qualifications, he must be a ***metallurgist, broad-gauged,*** and able to handle both men and material.

Lack of accurate knowledge on Mixing and Melting has beaten many Foundrymen

as practically 90 per cent of the money spent for LABOR and MATERIAL in making castings is spent BEFORE THE CUPOLA IS CHARGED. ***No*** other line of business has such EXPENDITURES delegated to men with so little SPECIAL TRAINING along ***metallurgical*** and ***business*** lines.

IN 1908 WE BEGAN ADVERTISING McLain's System of scientific mixing and melting thru these columns—but sold only 40 students the first year—WHY? BECAUSE we talked of SCIENCE—where ***tradition*** was the RULE.

Today more than 2700 Clients in all parts of the world claim our system is their standard Foundry Practice.

ANNOUNCEMENT: As McLain's System has been responsible for large savings and improved conditions in many iron foundries, we are asking a continuance of the patronage foundrymen so generously bestowed on us in the past, and now announce to the foundry trade that our course on STEEL FOUNDRY PRACTICE IS READY.

While steel castings are selling for high prices, still the cost of production is EXCESSIVE IN MOST PLANTS. It may be too many risers—cracked castings—blow holes—abnormal cleaning and molding costs—sand or steel mixtures, etc.—BUT WE CAN HELP YOU.

Don't experiment—we did all that—McLain's System will save you money because it stands for better practice—better quality—less losses

There's more to the story—RETURN COUPON TODAY.

Information Free

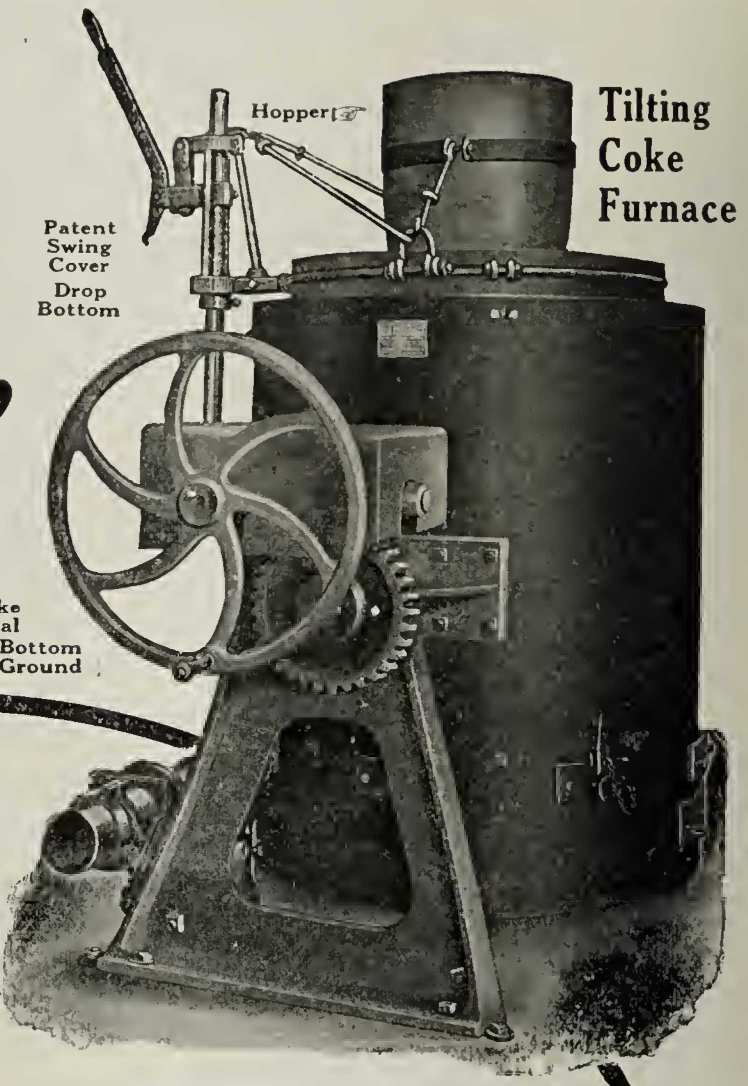
McLAIN'S SYSTEM, Inc.
803 Goldsmith Bldg., Milwaukee, Wis., U.S.A.

PIN THIS TO YOUR LETTERHEAD

McLAIN'S SYSTEM, INC., 803 Goldsmith Bldg., Milwaukee, Wis.
SEND FREE INFORMATION
Check with X—gray iron and semi-steel ( )
steel foundry practice ( )
Name..
Address..
Firm..
Position..
12/17

It will pay you to melt in

"MONARCHS"



This cut represents our Monarch crucible Tilting furnace, operating above ground, using coal or coke, air blast at the furnace 1 to 2 ounce. A virtual non-clinker furnace, no re-cooking necessary during the melting of each charge of metal. Furnaces are the last word in as near perfection as possible, rotating grate, drop bottom, natural draft on when air blast is off, prompt shipment, crucibles sizes from 40 to 400. We would be pleased to confer, correspond or quote.

Furnace in Melting Position, Hopper Feed, Shaker Grates

Monarch Metal Melting Furnaces, are essential strictly for your foundry and melting requirements, a big variety for all purposes. We recommend a certain furnace for the nature of metal to be melted and conditions to be met on a variety of metals. We would recommend also for jobbing purposes, our Stationary crucible furnace, pots to pull out, on standard metals and large tonnage our Tilting furnace.

In Tilting furnace we give you a variety, crucibles for oil, gas, coal or coke, Simplex, or Double chamber, or Tilting reverberatory without crucibles, various furnace capacities, as low or as high as desired. Catalogue thoroughly explains, we ask that prospective customers take up with us in regard to their necessities and we will recommend the type that we think best from our experience. All orders shipped prompt, all furnaces operated within reasonable distance.

Reverberatory Furnaces, we specialize in, Tilting and Stationary, capacity up to 10 ton.

Core Ovens built and shipped promptly, any size, any fuel, all asbestos insulated, the Acme is a double trolley, over head, the Arundel is drop front, write us.

Specializing in the melting of foundry metals, all classes of metals, a complete line of soft metal melting furnaces, reverberatory furnaces, furnaces for brass, bronze, aluminum, ferro alloys, etc., cyanide, barium chloride, heat treating, pumps, blowers, cupola lighters, mold dryers, ladle heaters.

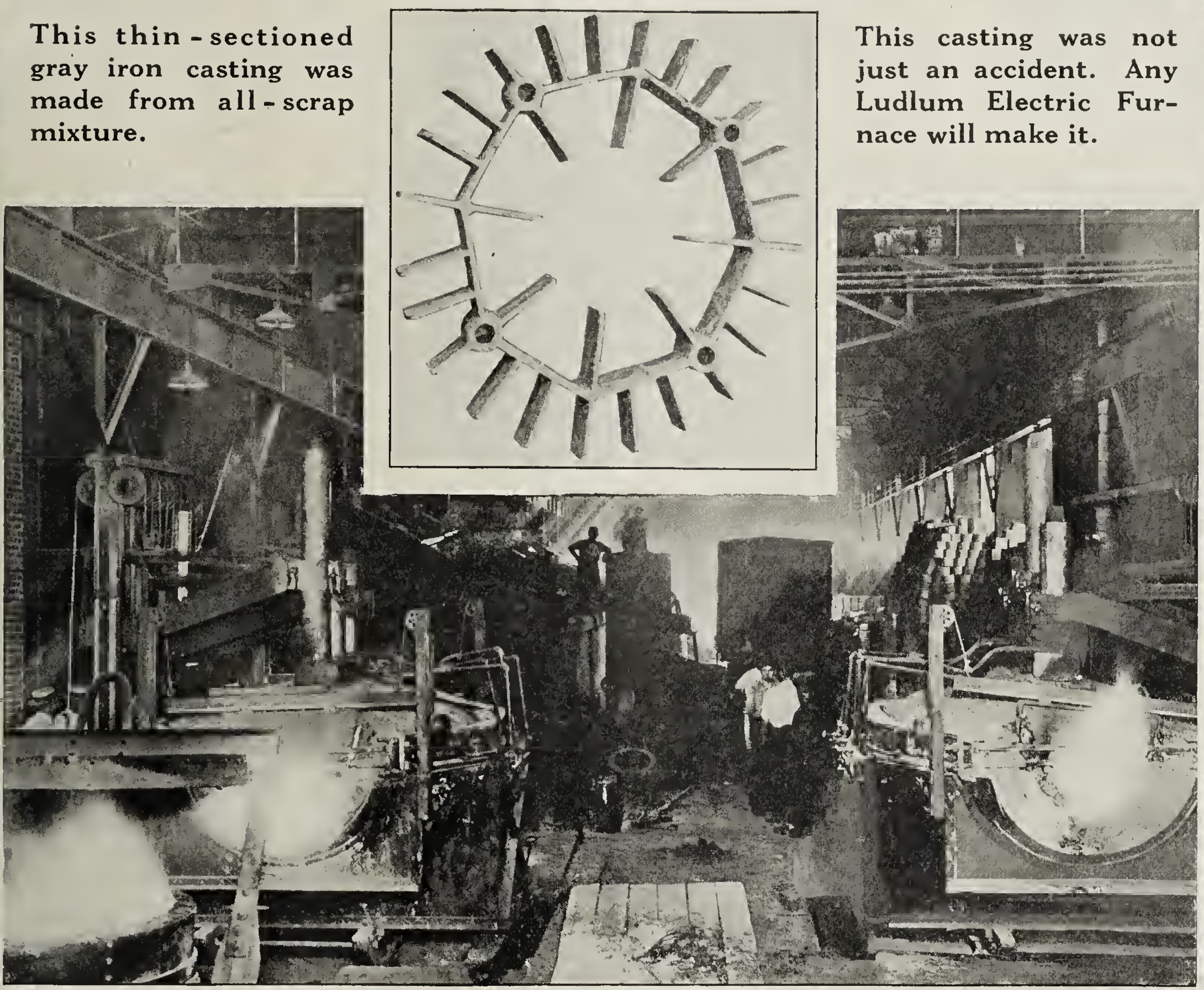
This is the time that the Government is favoring all with orders, therefore in order to protect yourself, take up with us immediately, in regard to Furnaces, etc.

The Monarch Engineering & Manufacturing Co.

1206 American Building, Baltimore, Md., U. S. A.
Shops—Curtis Bay, Md.
Catalog TF 12/1917

This thin-sectioned gray iron casting was made from all-scrap mixture.

This casting was not just an accident. Any Ludlum Electric Furnace will make it.



THE

LUDLUM ELECTRIC FURNACE

The LUDLUM Electric Furnace is a startling departure in that its elliptical, shape allows the arrangement of the three electrodes in a straight line, thus assuring an absolutely uniform heat throughout.

Having a door at each end, the "LUDLUM" can be charged in a very short time, and allows the slag to be removed easily and effectively.

One very remarkable feature of the LUDLUM Electric Furnace is that it will produce the highest grades of Pig Iron, Washed Metal, Cast Iron and Cast Steel of any desired analysis, FROM 100% SCRAP!

Alternate consecutive heats of high grade cast iron and cast steel are being made in the same LUDLUM Electric Furnace from the same low grade iron and steel scrap.

Complete details upon request.

Ludlum Electric Furnace Corporation
Woolworth Building
NEW YORK CITY

Relining gas producer with Hytempite and crushed old fire brick.

Forms in place, reverberatory smelting furnace, ready for lining.

Mixing Hytempite with old crushed fire brick for making rammed-in lining for smelting furnace.

Ramming-in lining, smelting furnace.

Crucible before repairing and surfacing with Hytempite.

Same crucibles after being repaired and resurfaced with Hytempite.

Bridge wall in boiler laid with Hytempite.

THINGS YOU SHOULD KNOW ABOUT

HYTEMPITE

What is it?

HYTEMPITE is a scientifically compounded refractory plastic material for bonding fire brick and kindred uses.

What does it do?

HYTEMPITE forms a lasting union between the materials to be joined, sets at normal temperatures and retains its strength regardless of the heat it is subjected to up to about 3100° F. (1700° C.) or a temperature at which the best quality fire brick loses its strength and becomes soft.

Why is it better than fire clay?

HYTEMPITE is better than fire clay because fire clay and water has no binding strength, does not support the brick work or knit together the materials with which it is used, becomes loose from constant expansion and contraction, disintegrates or falls out forming crevices or cracks and does not maintain a gas or air tight structure.

Does it depend on heat for a bond?

No. HYTEMPITE air sets at normal temperatures, making a wall of uniform strength throughout.

Will it stop or prevent air and gas leaks?

Yes, HYTEMPITE will not only stop these leaks, but will withstand the expansion and contraction caused by heat without loosening.

What proves its merit?

Over 75% of its sales are repeat orders.

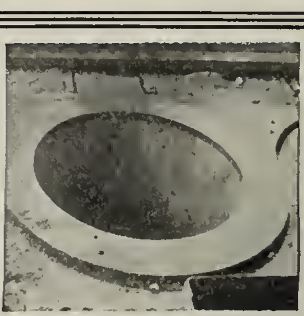
What are some of its uses?

1. For laying fire brick and tile.
2. For tightening old walls and arches, sealing openings in new walls, stacks, etc., to make them air-tight, lining doors, etc.
3. Hot patching in furnaces, gas retorts, etc.
4. Making special tile and shapes with crushed old fire brick or carborundum fire sand.
5. Making rammed-in linings with your crushed old fire brick or carborundum fire sand.
6. Bonding new courses or a veneer of fire brick to old walls.
7. Preventing leaks between bricks and iron work.
8. As a wash for surfacing brick work.
9. As a grout diluted or neat, according to requirements.
10. For lining ladles.
11. For patching or building up tuyeres, etc., etc.

Who makes HYTEMPITE?

An organization that has had over twenty years' experience in furnace design, construction and operation and which understands what is required of a furnace cement and stands back of HYTEMPITE, FURNISHING PERSONAL SERVICE.

Quigley Furnace Specialties Co.
26 Cortlandt Street New York

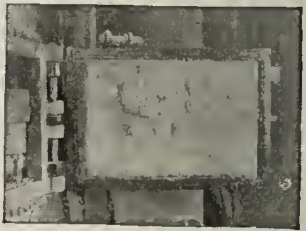

Pit crucible furnace before lining.

Form in place, partially lined.

Pit crucible furnace relined with Hytempite and carborundum rammed-in.

Setting arch in small furnace with Hytempite.

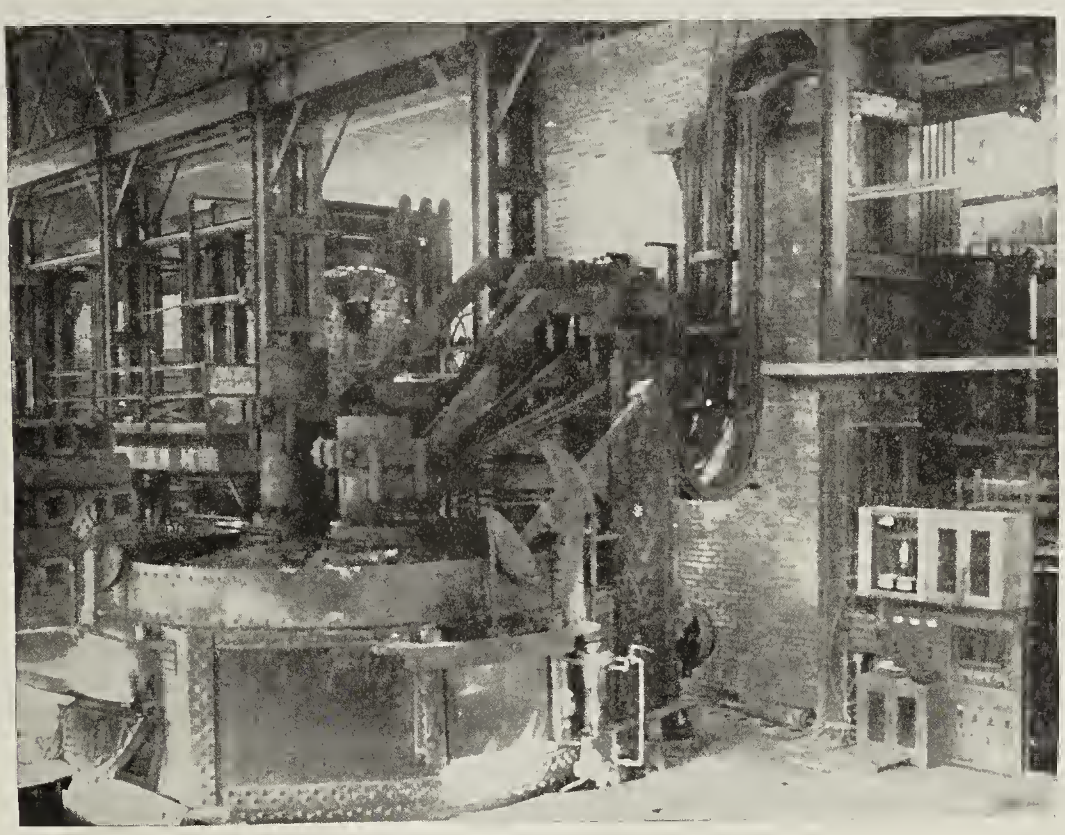
Door before being repaired with Hytempite. Bricks falling out.


Furnace door repaired with Hytempite.

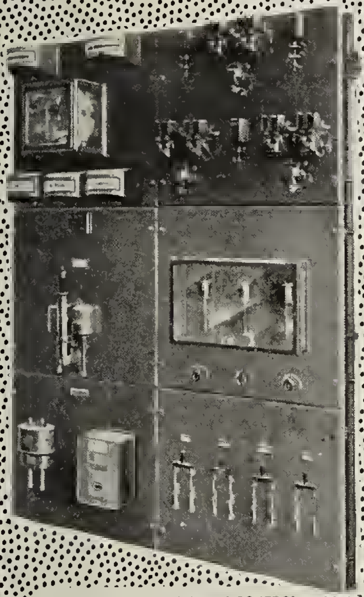
Ramming lining in open flame melting furnace.

G-E Control Equipment for Electric Arc Furnaces

ELECTRIC FURNACE TRANSFORMER



15 ton 3 phase Arc Furnace, Standard Seamless Tube Co., Economy, Pa.



PRIMARY AND SECONDARY CONTROL

G-E Automatic Control for Steel Furnaces

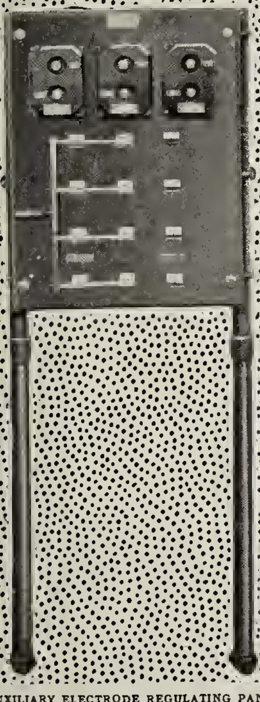
The General Electric Company is prepared to furnish complete equipment for the hand and automatic control of electric arc furnaces.

Scores of these equipments are in use throughout this country and are giving universal satisfaction.

G-E Automatic Control is entirely electrical in character, without countershaft or belts, and has no constantly moving parts to wear and necessitate frequent replacement.

This equipment assures close power input control and electrode movements without continuous racking of the entire mechanism.

Additional details will be promptly supplied by our nearest office. Write today.

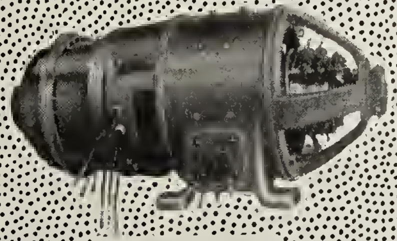


AUXILIARY ELECTRODE REGULATING PANEL

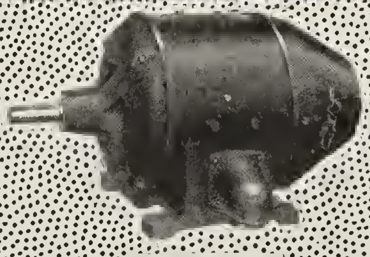
General Electric Company

General Office: Schenectady, N. Y. District Offices in:
Atlanta, Ga. Chicago, Ill. Boston, Mass. Cincinnati, Ohio San Francisco, Cal.
New York, N. Y. St. Louis, Mo. Denver, Colo. Philadelphia, Pa.
Sales Offices in all Large Cities

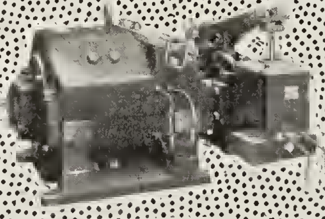
7359



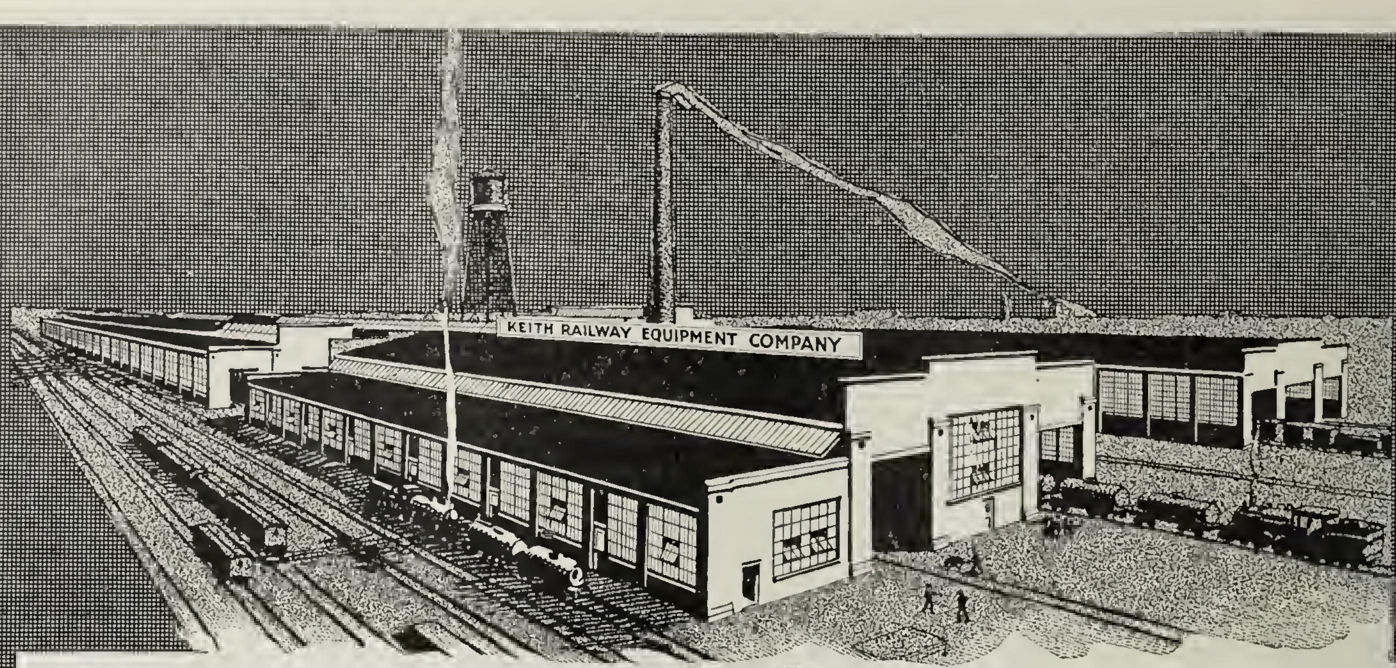
MOTOR-GENERATOR SET



ELECTRODE MOTOR



TILTING MOTOR



You Need Your New Foundry NOW—

—but you who are responsible for dividends want *more* than rapid construction work in this new foundry of yours.

If your production is to be handled on a permanently profitable basis you must have a foundry which is designed for your particular needs—which fits the manufacturing conditions you are actually up against.

Many of the executives who direct the representative industries of the country turn this problem completely over to

F·D·C·SERVICE

FACTORIES - FOUNDRIES - MACHINE SHOPS - WAREHOUSES

A Few Nationally Known Foundry Operators Who Are Clients of F. D. C. SERVICE

Saginaw Malleable Iron Works
Saginaw, Mich.
Temple Manufacturing Co.
Chicago, Ill.
Kokomo Brass Works
Kokomo, Ind.
Hammond Malleable Iron Works
Hammond, Ind.
Gilliam Manufacturing Co.
Canton, Ohio
The W. T. Rawleigh Co.
Freeport, Ill.
Garden City Spring Works
Chicago, Ill.
Vermillion Malleable Iron Co.
Hoopeston, Ill.
Hoosier Iron Works
Kokomo, Ind.

F. D. C. Service relieves you of all your construction details and leaves you free to concentrate your attention upon vital issues developed by the war.

F. D. C. Service begins with making a comprehensive analysis to determine the kind of a foundry which most nearly meets your exact needs—and does not end until your production is under way.

Your foundry will be under roof in thirty to sixty days—and in actual operation within ninety days after you call on F. D. C. Service—and it will be *your* foundry built for you *individually*.

This kind of service is original with us—and is the result of fifteen years broad and successful experience in industrial construction. For complete particulars address

A Book On Foundry Construction for Industrial Executives

Executives who have to contend with present day construction problems will find it profitable to read "*A Better Way to Build Your New Foundry*", a clear, concise book which digests the fifteen years rich experience on Industrial Building which is back of F. D. C. Service. If you are interested in the methods by which the concerns at the left handle their own construction problems, just write "Send me your Construction Book as mentioned in DECEMBER FOUNDRY."

A BETTER WAY TO BUILD YOUR NEW FOUNDRY

FRANK D. CHASE
INDUSTRIAL ENGINEER

CHICAGO: PEOPLES GAS BUILDING WHITEHALL BUILDING: NEW YORK

Smokeless Foundries

Talk of the "joy of living" in a foundry!

Yet it's not absurd—if the foundry be modern. The old acrid, murky cavern is out of date today.

Visit a foundry with a Pond Truss lighting and ventilating roof, and watch the smoke go straight up and out!

Sniff the clean fresh air. Note the absence of stale down-drafts.

See the splendid daylight, reaching every part of the floor.

Learn about the workers' freedom from heat prostrations and colds.

Rain or shine, summer or winter, it's the same story of fresh air, abundant light, and zest for work.

The General Electric Co. (at Erie, Pa.), Moline (Ill.) Malleable Iron Co., Erie Malleable Iron Co., Buick Motor Co., Maxwell Motors Co., Youngstown Sheet and Tube Co., and Hydraulic Pressed Steel Co. are some of the big concerns that have secured year-round maximum output and reduced labor wastage by erecting Pond Truss foundries and forge shops.

Want to know more? Ask for Catalogue No. 9 and particulars to fit your own foundry. We consider the Pond Truss, weather proofed with top-hung Pond Continuous Sash, the last word in scientific roof design for all-weather ventilation and daylighting. The design is patented; its use is licensed in consideration of the exclusive use of Lupton Products in buildings so planned.

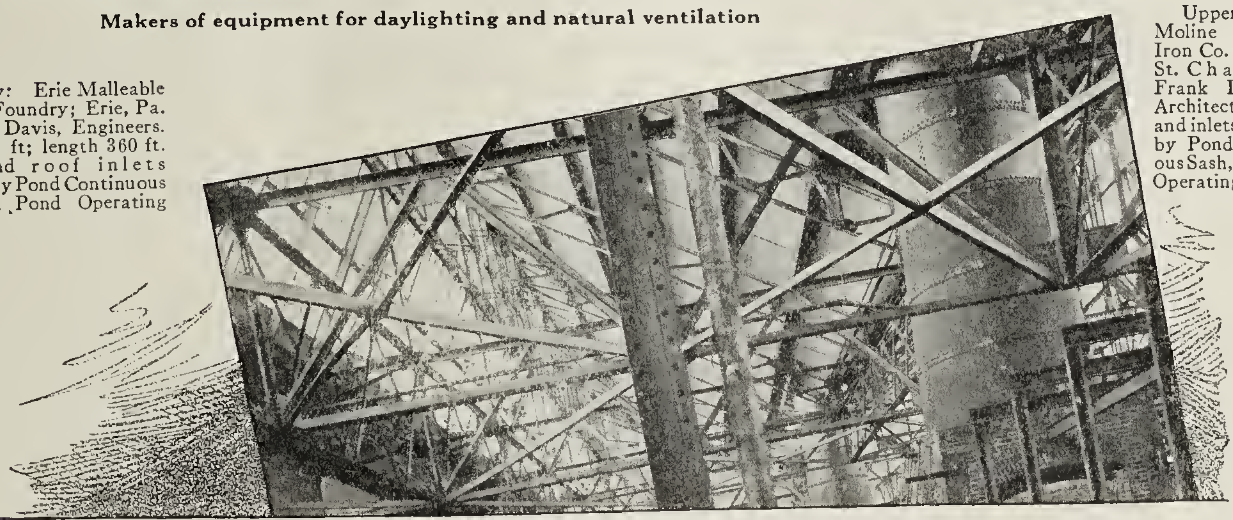
DAVID LUPTON'S SONS COMPANY

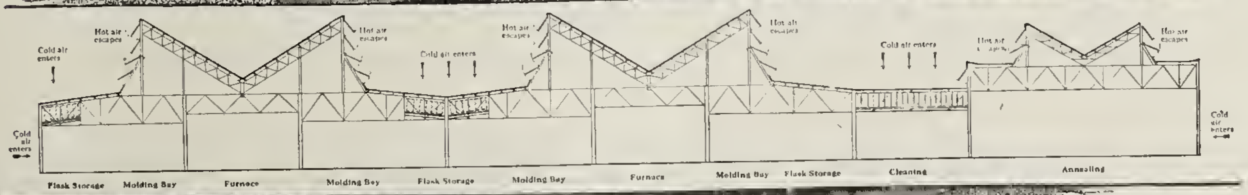
Clearfield and Janney Sts. Philadelphia, Pa.

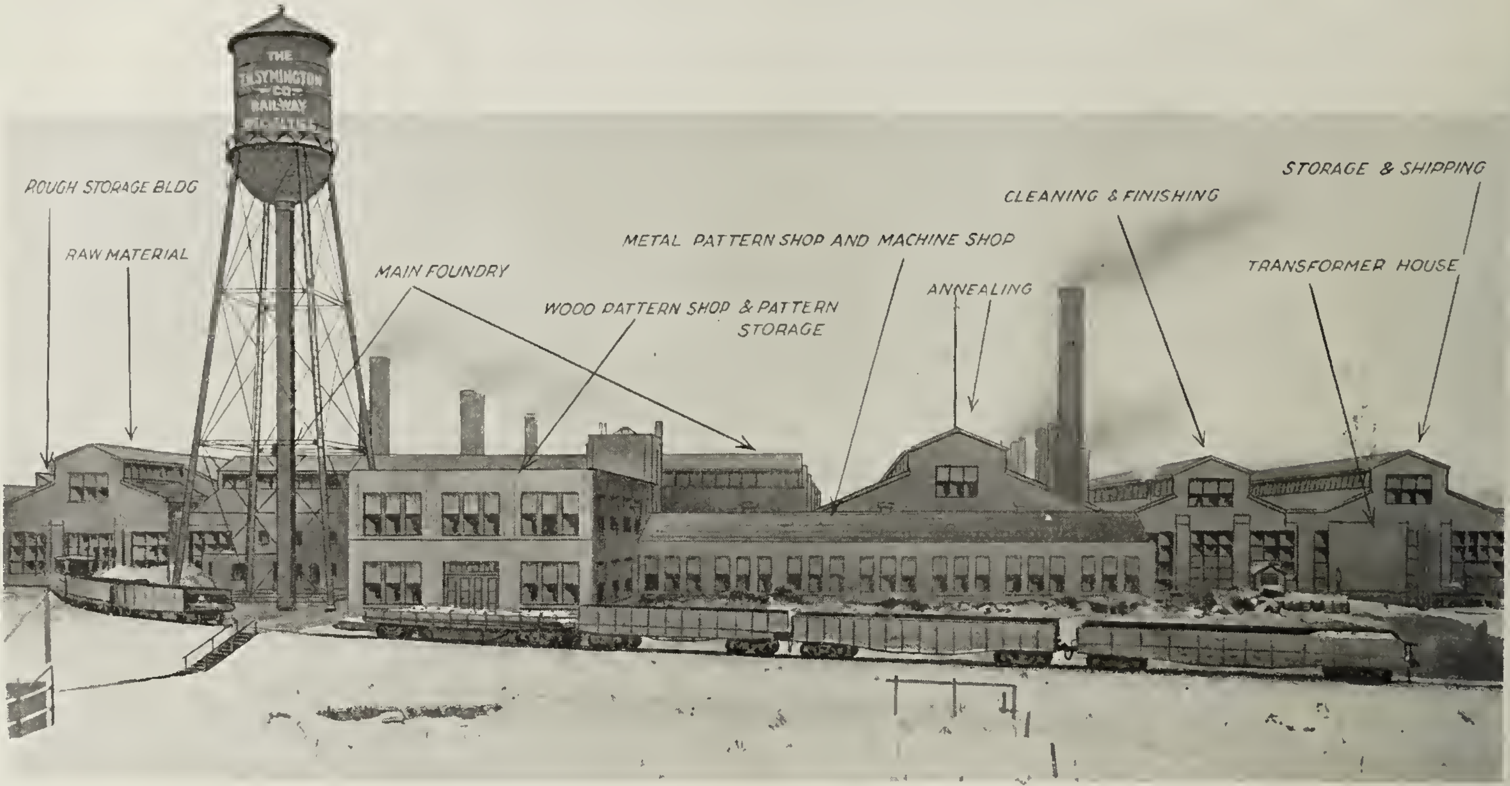
Makers of equipment for daylighting and natural ventilation

Upper view: Moline Malleable Iron Co. Foundry; St. Charles, Ill. Frank D. Chase, Architect. Outlets and inlets protected by Pond Continuous Sash, with Pond Operating Device.

Lower view: Erie Malleable Iron Co. Foundry; Erie, Pa. Hunting & Davis, Engineers. Width 405 ft; length 360 ft. Outlets and roof inlets protected by Pond Continuous Sash, with Pond Operating Device.







THE T. H. SYMINGTON COMPANY, ROCHESTER, N. Y.

How Soon Will You Lose More Men?

Every new day brings its increased demands for more output, with letters "Why don't you ship?" and on the other hand comes a shortening of labor.

Why run want ads for men who can't be had? Why take your time to plan or build? We are busy, too, but we can find time to execute your commissions and make your investigations so that you need not add to your present worries.

Do you need a better production or routing system?

A better shipping plan?

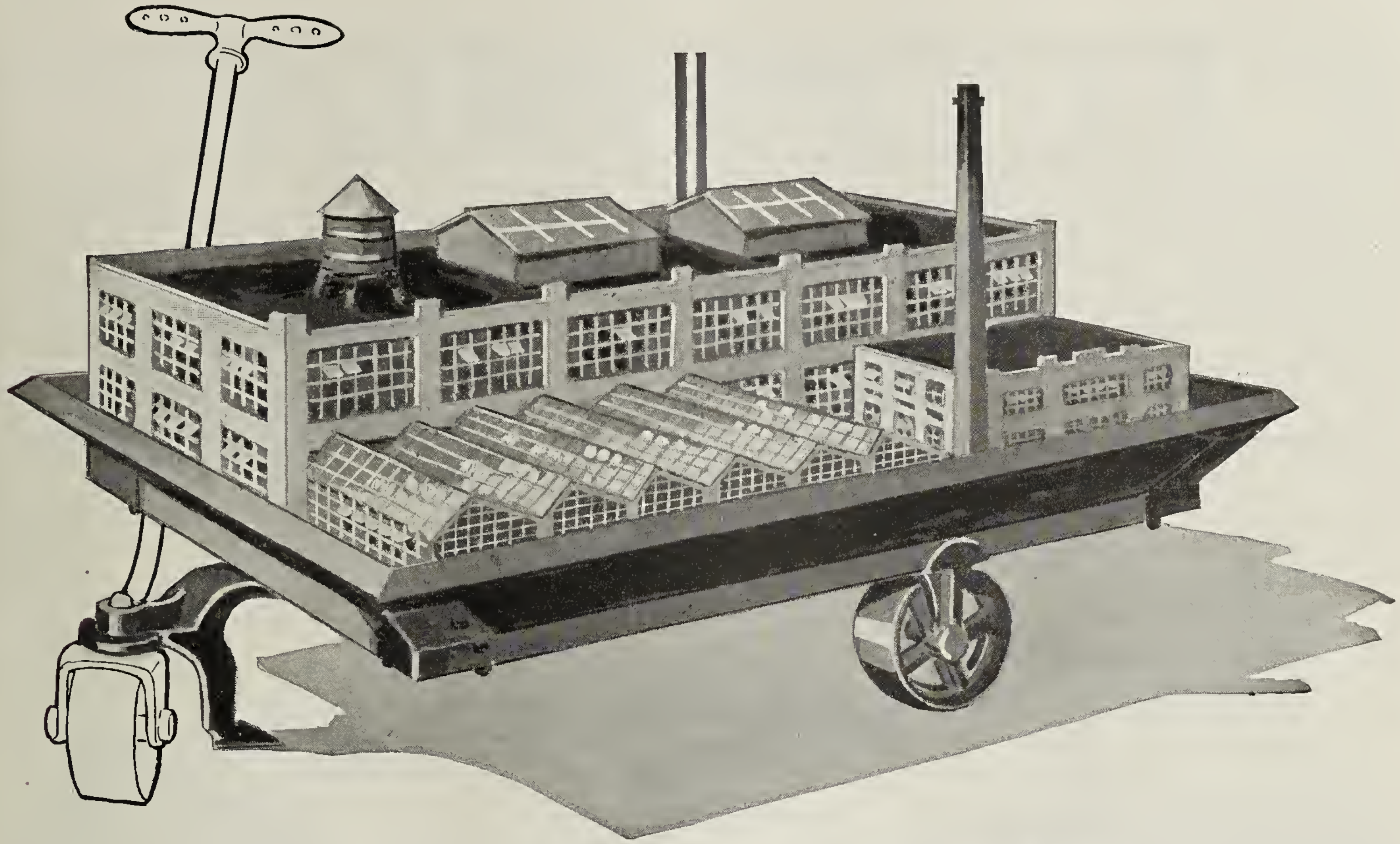
More productive special machinery?

A new warehouse or a new factory?

Whatever your problem, confer with us for we have had long experience in planning for metal manufacturers all sorts of new plants, additions, etc.

HOOPER-FALKENAU ENGINEERING COMPANY
WOOLWORTH BUILDING NEW YORK, N. Y.

34-7



Put Your Plant—ON WHEELS

With Material Ready to Move Continuously

in Howe Trucks all the way through the shop, working from one truck to another. Every time a part of your product in the process of manufacture is thrown on the floor or into a box, the profitless operation of picking it up again becomes inevitable. Multiply this lost motion by ten thousand and a threatening leak in profits develops.

Then, too, the materials are all at a convenient height for the workman. He handles them more rapidly and with less fatigue. Departments formerly congested show increased production and less confusion. You can maintain a steady flow of production with

Meeting Man Shortage

With the roller bearing, Howe Trucks ($17.10) each. One *little* man with a jack tongue ($6.50) pulls many ***big*** loads.

Howe (Tongue Elevated) Trucks

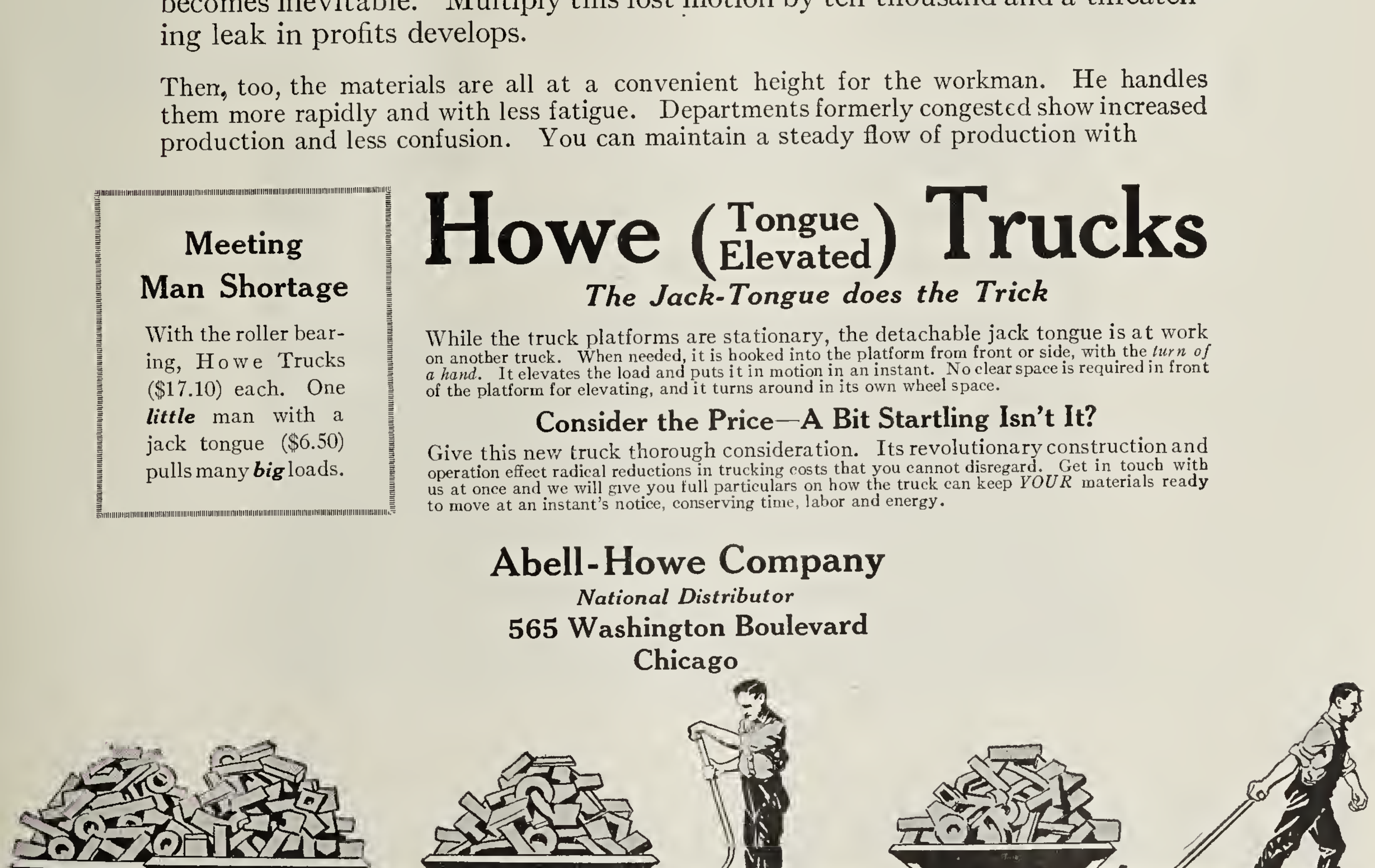
The Jack-Tongue does the Trick

While the truck platforms are stationary, the detachable jack tongue is at work on another truck. When needed, it is hooked into the platform from front or side, with the *turn of a hand*. It elevates the load and puts it in motion in an instant. No clear space is required in front of the platform for elevating, and it turns around in its own wheel space.

Consider the Price—A Bit Startling Isn't It?

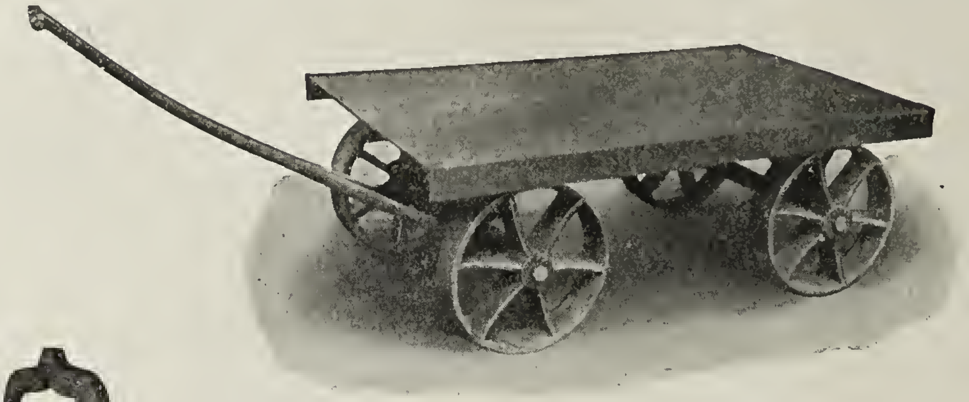
Give this new truck thorough consideration. Its revolutionary construction and operation effect radical reductions in trucking costs that you cannot disregard. Get in touch with us at once and we will give you full particulars on how the truck can keep *YOUR* materials ready to move at an instant's notice, conserving time, labor and energy.

Abell-Howe Company
National Distributor
565 Washington Boulevard
Chicago

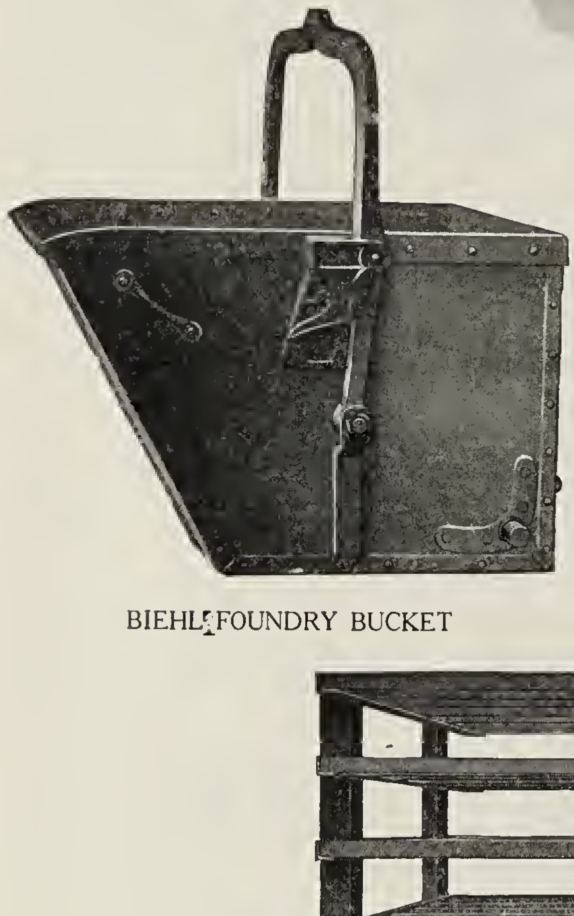


ECONOMIZE

on labor



BIEHL FOUNDRY TRUCK



BIEHL FOUNDRY BUCKET

From today on, the shortage of labor will steadily increase.

Protect your industry and help meet the labor shortage by installing equipment that will reduce the amount of man power required.

Biehl Foundry Equipment will take the place of the men that Uncle Sam needs from your foundry. Let us explain how—send at once for our new catalog.

BIEHL FOUNDRY BUCKET DUMPED

BIEHL CORE OVEN CAR

The Biehl Iron Works, Inc., Reading, Penna.

Representative: Beckwith Machinery Co., 108 Parkway, N. S., Pittsburgh, Pa.

One of the Largest Foundries for Automobile Cylinders-

USE

BROWNHOIST

Hand Traveling Cranes

EASY Operation is essential in a hand traveling crane. The easier the crane operates, tbe more output for the workmen—as less energy is used in moving the loads. It means more work, better work, and more speed, and results in better satisfied workmen. A good crane that is put up right is a big asset to a moulding floor.

Brownhoist Cranes are built to give easy operation. All except the smallest, are equipped with roller-bearings. And each is equipped with a squaring shaft connecting the two end trucks which keeps the trucks in alignment. That they give satisfactory results is proved by the repeat orders received. Once a Brownhoist Crane is used, it will almost always be Brownhoists thereafter.

These Cranes are made in various capacities and for different spans, for operating on T-rail, I-Beam or Channel Tracks.

Catalog P

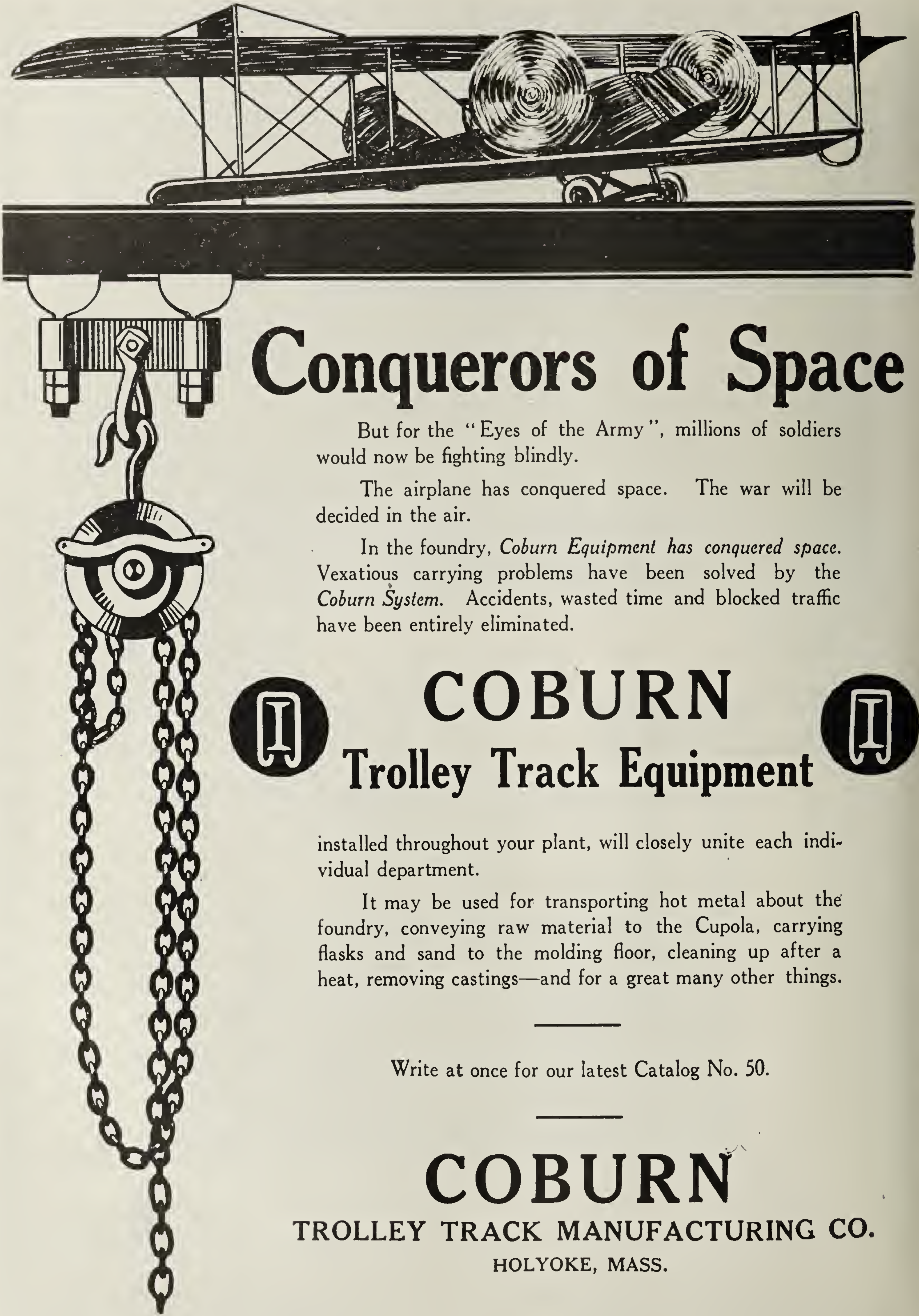
describes and illustrates the different types. And it also lists the cranes, giving weights, wheel loads, clearances and prices. This catalog will be sent on request.

The Brown Hoisting Machinery Co.

Cleveland, Ohio, U. S. A.

Engineers and Manufacturers of Heavy Dock Machinery,
Bridge Cranes, etc., as well as smaller Cranes and Hoists

Branch Offices in New York, Pittsburgh, Chicago, San Francisco, and (Portland, Ore., Colby Eng'r Co.)



Conquerors of Space

But for the "Eyes of the Army", millions of soldiers would now be fighting blindly.

The airplane has conquered space. The war will be decided in the air.

In the foundry, *Coburn Equipment has conquered space.* Vexatious carrying problems have been solved by the *Coburn System.* Accidents, wasted time and blocked traffic have been entirely eliminated.

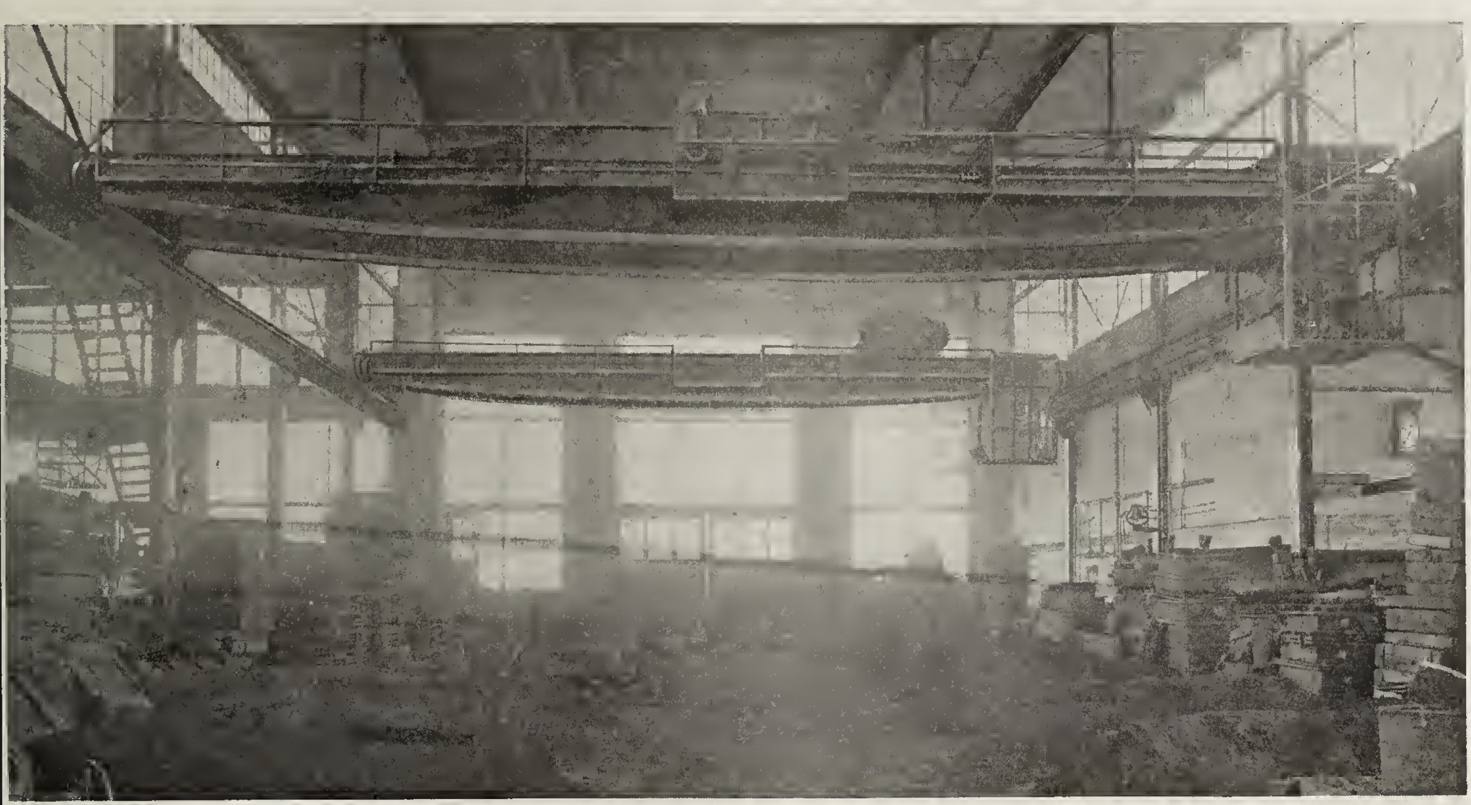
COBURN
Trolley Track Equipment

installed throughout your plant, will closely unite each individual department.

It may be used for transporting hot metal about the foundry, conveying raw material to the Cupola, carrying flasks and sand to the molding floor, cleaning up after a heat, removing castings—and for a great many other things.

Write at once for our latest Catalog No. 50.

COBURN
TROLLEY TRACK MANUFACTURING CO.
HOLYOKE, MASS.



Cut shows two 15 ton Bedford Cranes in the plant of the Jas. A. Brady Foundry Company, Chicago, furnished by Scully-Jones & Company, Chicago.

Standard Cranes delivered in from three to four months.

ELECTRIC CRANES

HAND POWER CRANES

SCULLY-JONES & CO.

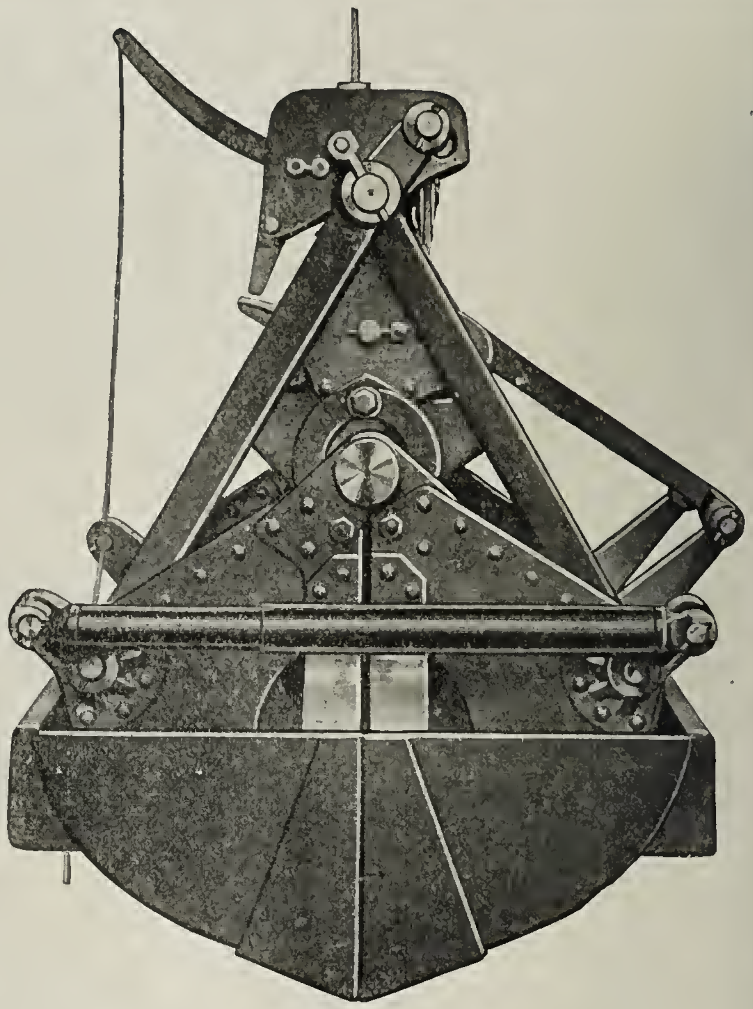
Complete Foundry Equipment

Railway Exchange Building
CHICAGO, ILL.

SEE OUR ADVERTISEMENT IN CLASSIFIED SECTION FOR PARTIAL LIST USED FOUNDRY EQUIPMENT WE CAN SUPPLY

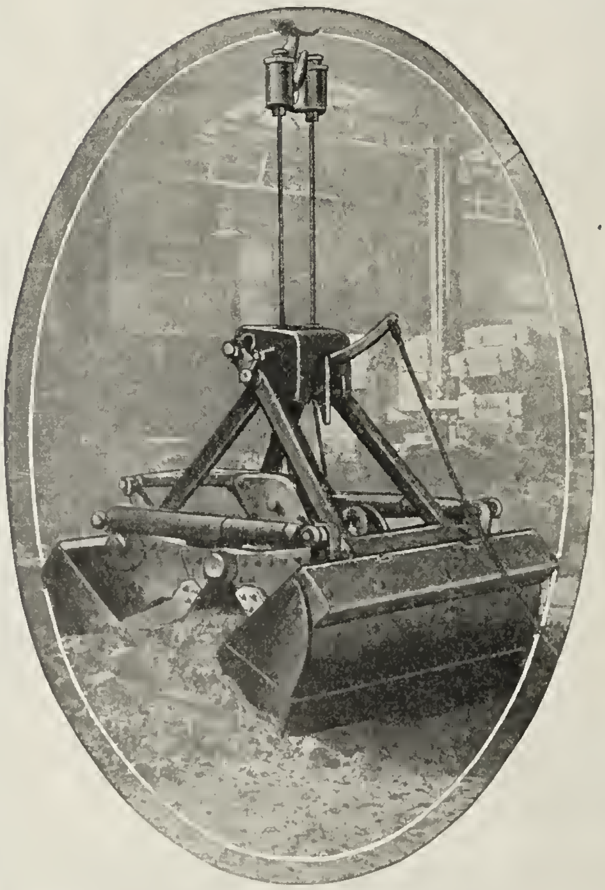
STURDY and PRACTICAL

Built as a well-balanced grab-bucket should be, with no intricate operating mechanism to break down and require attention.



P. & H.

SINGLE-LINE GRAB-BUCKET



Ready when you need it—hooked on in a jiffy and set aside just as fast—crane always available for other service.

Write your name in margin for bulletin 101

PAWLING & HARNISCHFEGER
Milwaukee, Wis.

SHEPARD
ELECTRIC CRANE & HOIST CO.

MONTOUR FALLS, N.Y.
NEW YORK, PHILADELPHIA, PITTSBURGH, CHICAGO.
BOSTON, BALTIMORE, BIRMINGHAM, ALA. SAN FRANCISCO.
MONTREAL, MELBOURNE, AUSTRL. LONDON.

for Economical Foundry Service

Shepard Enclosed Design
KEEPS THE UP-KEEP DOWN

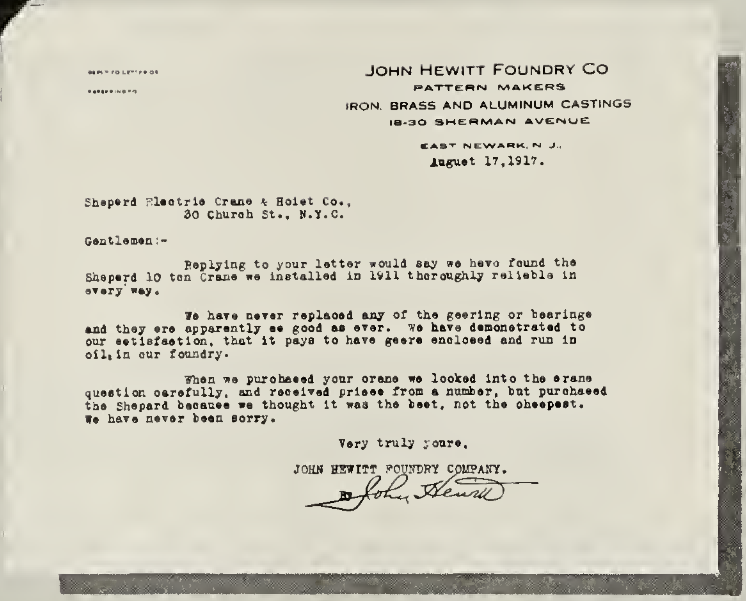
Wherever the cost of crane up-keep in a plant is excessive—it can usually be attributed to insufficient lubrication, grit and foreign matter in the crane bearings, or breaking of gear teeth and other moving parts, due to defective alignment.

Cranes of necessity must be located in places where they are exposed to unfavorable conditions,—places that are unfavorable for cleanliness and more or less out of the way for inspection and supervision.

Low up-keep records of Shepard Hoists and Cranes in over ninety lines of industry offer evidence of their economical maintenance, due to the ability of SHEPARD ENCLOSED DESIGN to meet and overcome unfavorable conditions.

The features of this Enclosed Design are BALANCED DRIVE, insuring alignment of the gearing under all conditions, and permitting bath oiling of all moving parts in a dust tight and grit proof case,—yet the design permits of accessibility.

Send for a copy of Hand Book C.



JOHN HEWITT FOUNDRY CO
PATTERN MAKERS
IRON, BRASS AND ALUMINUM CASTINGS
18-30 SHERMAN AVENUE

EAST NEWARK, N. J.
August 17, 1917.

Shepard Electric Crane & Hoist Co.,
30 Church St., N.Y.C.

Gentlemen:-

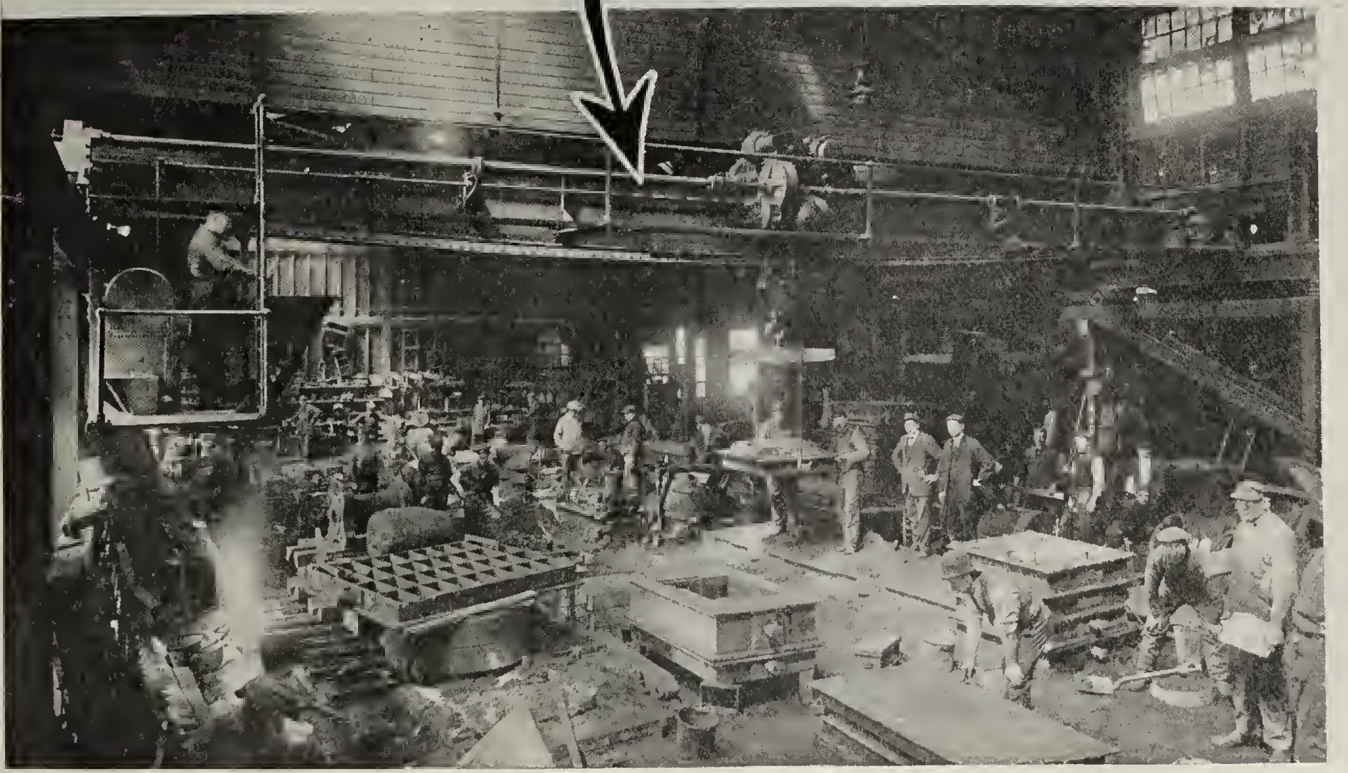
Replying to your letter would say we have found the Shepard 10 ton Crane we installed in 1911 thoroughly reliable in every way.

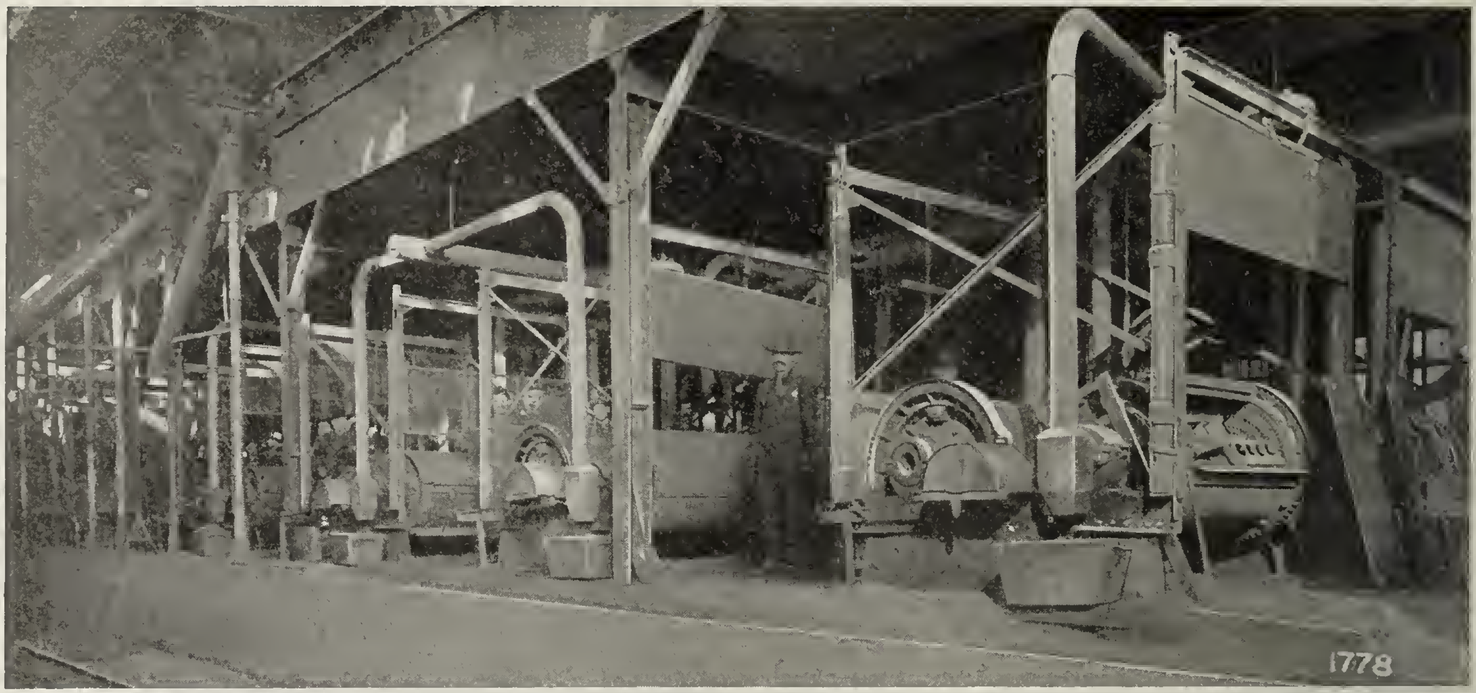
We have never replaced any of the gearing or bearings and they are apparently as good as ever. We have demonstrated to our satisfaction, that it pays to have gears enclosed and run in oil, in our foundry.

When we purchased your crane we looked into the crane question carefully, and received prices from a number, but purchased the Shepard because we thought it was the best, not the cheapest. We have never been sorry.

Very truly yours,

JOHN HEWITT FOUNDRY COMPANY.
By John Hewitt



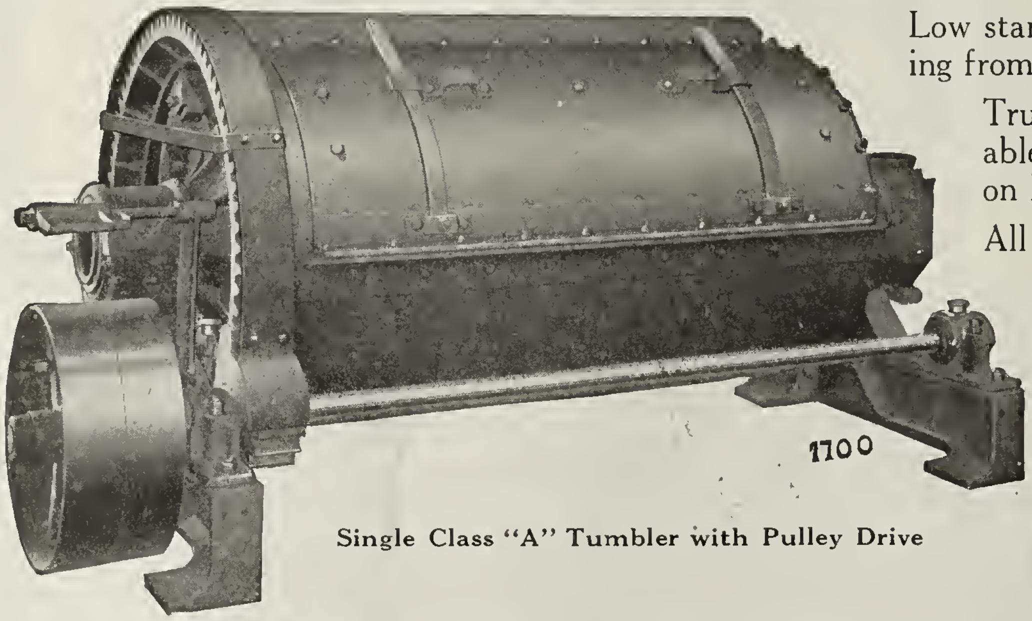


PARTIAL VIEW OF TYPE "A" TUMBLERS INSTALLED IN FOUNDRY OF A LARGE AUTOMOBILE MANUFACTURER, DETROIT, MICH. SEVENTY-EIGHT MILLS FURNISHED THIS ONE PLANT.

78 Whiting Tumblers in this Plant

Large buyers are careful buyers—they investigate the merits of an article before buying and a large installation like this, representing several repeat orders, is a good indication of how Whiting Mills are performing.

A glance at our specifications will tell you why. The barrel is of heavy steel plate in one piece, door being cut from solid after rolling and properly reinforced.



Single Class "A" Tumbler with Pulley Drive

Low standards and shaft permit loading from either side.

Trunions are hollow and removable and fit into machined socket on head. Easily renewed.

All castings of ample section to stand stress of mill-room service.

All details result of years of study and experience with foundry equipment.

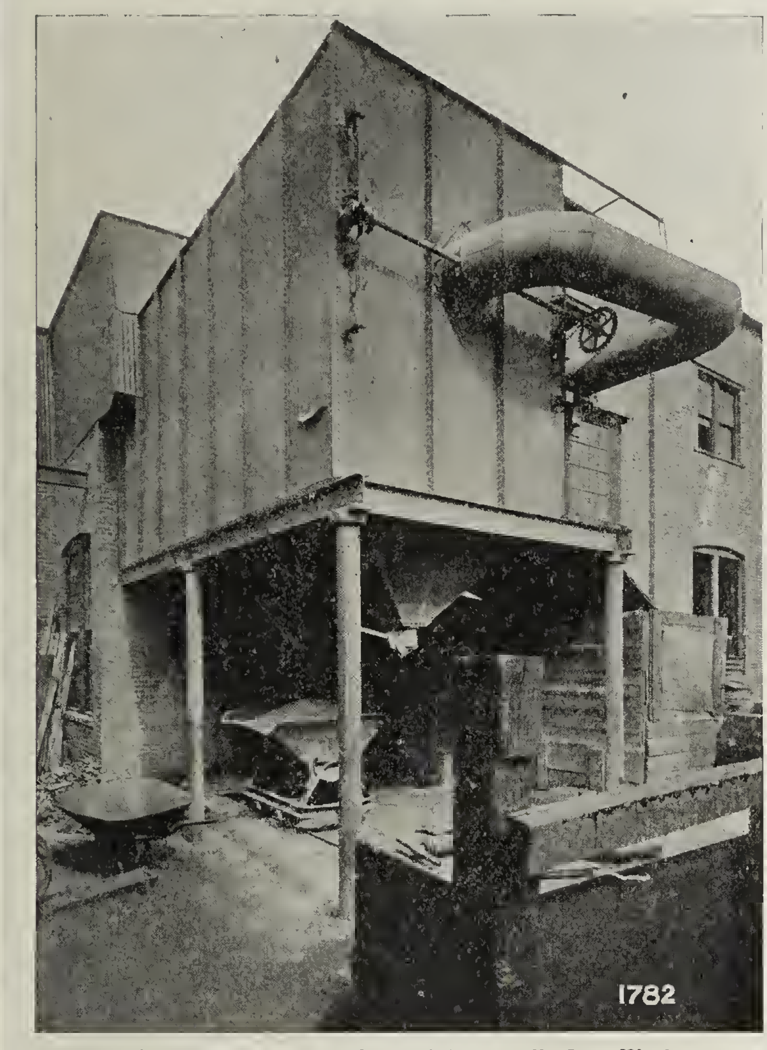
New Catalog 132 on request

Any money saved by installing "Light" Equipment is soon eaten up by repair bills.

Complete Foundry Equipments

WHITING
FOUNDRY EQUIPMENT CO.
HARVEY-ILL. U. S. A.
CHICAGO SUBURB.

Cranes of all Types



Whiting Arrester in Plant of Somerville Iron Works, Somerville, N. J.

Healthy Air in Your Mill Room

is possible only by removing the dust. Our cloth-screen arrester retains all the fine vapor dust and passes cleaned air back into the room. The heat units saved in this way are quite an item.

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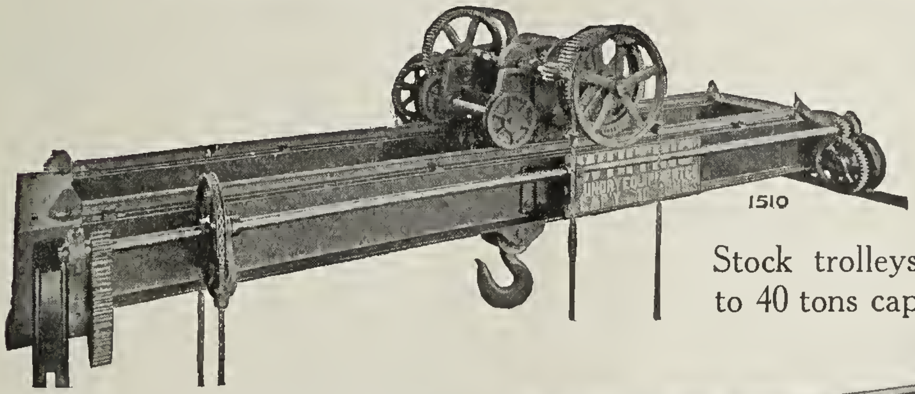

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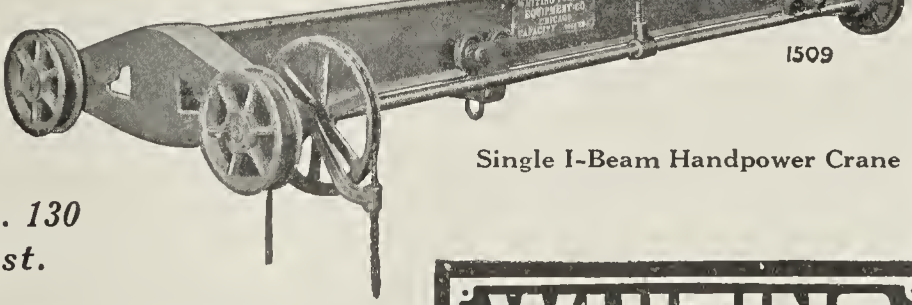

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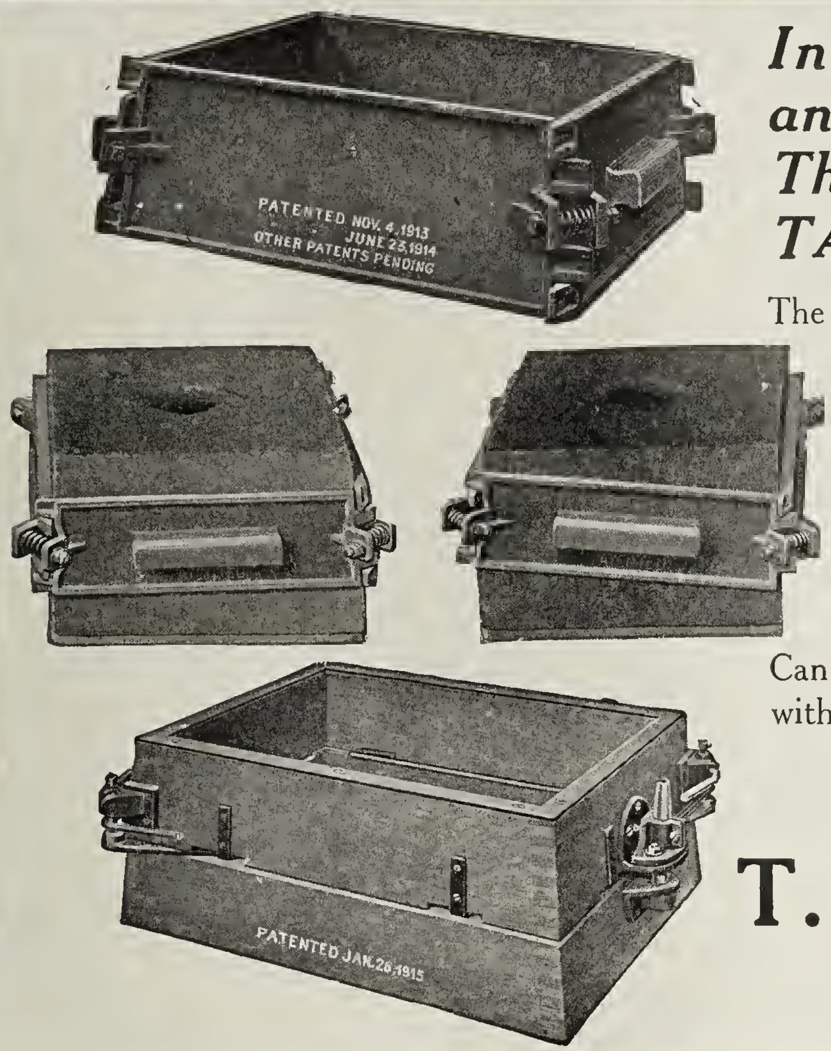

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No. 0-A
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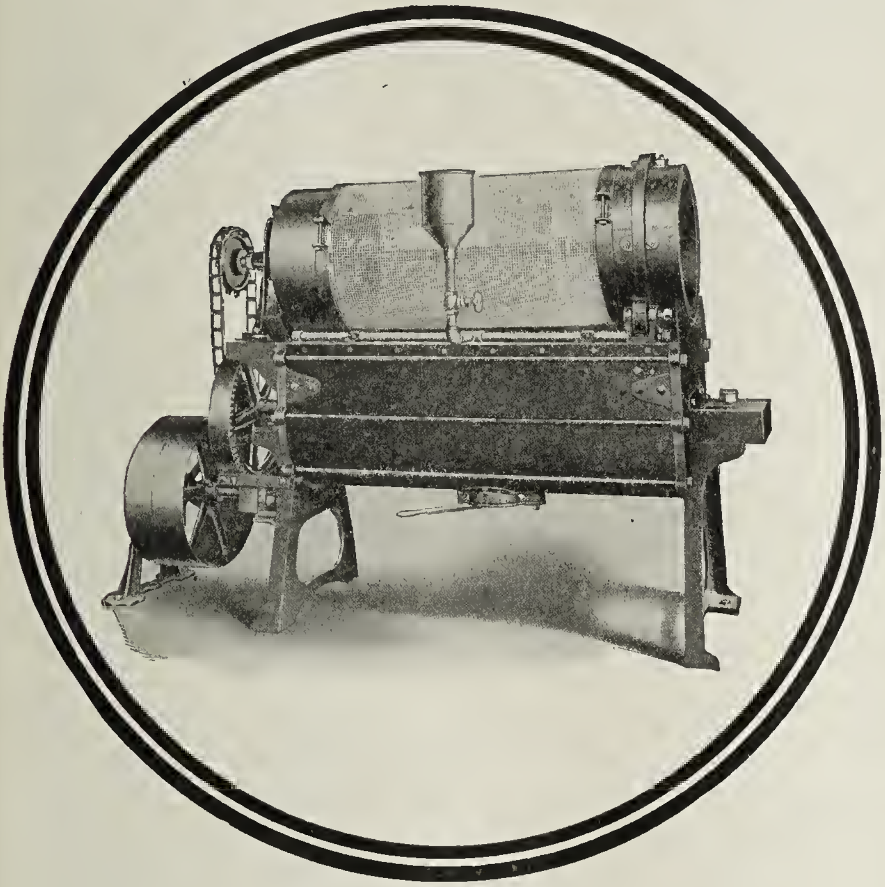

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Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Toledo Bridge & Crane Co., Toledo, O.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York City.

CRANES (Jib).
Brown Hoisting Machy. Co., The, Cleveland.
Manning, Maxwell & Moore, Inc., New York.
Northern Engineering Works, Detroit, Mich.
Q. M. S., The, Co., Chicago, Ill.
Shaw Electric Crane Co., New York, N. Y.
Whiting Fdy. Equipment Co., Harvey, Ill.

CRANES (Locomotive).
Brown Hoisting Machy. Co., The, Cleveland.
Wonham, Bates & Goode, Inc., New York.

CRANES (Wall).
Niles-Bement-Pond Co., New York City.

CRATING LUMBER.
Coale, Thomas E., Lumber Co., Philadelphia, Pa.
Smith, Fassett & Co., N. Tonawanda, N. Y.

CRUCIBLES.
Barnett, Oscar, Fdy. Co., Irvington, N. J.
Crucible Co., The, of New Jersey, New York.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Foreign Crucibles Corp., Ltd., New York City.
Gautier, J. H., & Co., Jersey City, N. J.
General Platers' Supply Co., New York, N. Y.
New Chicago Crucible Co., Chicago.
McCullough-Dalzell Crucible Co., Pittsburgh.
Vesuvius Crucible Co., Swissvale, Pa.
Woodison, The E. J., Co., Detroit, Mich.

CRUCIBLE LIFTERS.
Foundry Equipment Co., Cleveland.

CRUCIBLE SHANKS AND TONGS.
Central Foundry Supply Co., Columbus, O.

CRUSHED STEEL.
Harrison Supply Co., Boston, Mass.
Pittsburgh Crushed Steel Co., Pittsburgh, Pa.

CRUSHERS.
Standard Equip. Co., The, New Haven, Conn.

CUPOLA BLOCKS.
Wagner Fire Brick Co., Scranton, Pa.
Woodison, E. J., Co., The, Detroit, Mich.

CUPOLA BRICK.
Peekskill Fire Brick Works, Inc., Peekskill, N. Y.
Stevens, Frederic B., Detroit, Mich.
Whiting Foundry Equipment Co., Harvey, Ill.

CUPOLA CHARGING MACHINE.
Whiting Foundry Equipment Co., Harvey, Ill.

CUPOLA DAUB.
Paxson, J. W., & Co., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.
Woodison, The E. J., Co., Detroit, Mich.

CUPOLA LIGHTERS.
Macleod Company, The, Cincinnati, O.
Paxson, J. W., & Co., Philadelphia, Pa.
U. S. Chaplet & Supply Co., New York City.

CUPOLAS.
Central Foundry Supply Co., Columbus, O.
Northern Engineering Works, Detroit, Mich.
Paxson, J. W., Co., Philadelphia, Pa.
Tropenas Converter Co., Brooklyn, N. Y.
Whiting Fdy. Equipment Co., Harvey, Ill.

CUTTERS (Steel).
Moltrup Steel Products Co., Beaver Falls, Pa.

CUTTING AND WELDING EQUIPMENT. (Electric Arc).
General Electric Co., Schenectady, N. Y.
Lincoln Electric Co., Cleveland, O.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

CUTTING AND WELDING APPARATUS (Oxy-Acetylene).
Cox Brass Mfg. Co., Albany, N. Y.
Davis-Bournonville Co., Jersey City, N. J.
Linde Air Products Co., New York City.
Macleod Company, The, Cincinnati, O.
Milburn, The, Alexander, Co., Baltimore, Md.
Oxweld Acetylene Co., Chicago, Ill.
Prest-O-Lite Co., Inc., Indianapolis, Ind.

CUTTING COMPOUND.
Cataract Refining & Mfg. Co., Buffalo, N. Y.

CUTTING OIL.
American Oil Refining Co., New York, N. Y.
Cataract Refining & Mfg. Co., Buffalo, N. Y.

DEOXIDIZERS.
American Boron Products Co., Reading, Pa.

DERRICKS AND DERRICK FITTINGS.
Hayward Co., The, New York City.

DESIGNERS (Machinery).
Co-operative Engineering Co., Inc., New York.

DEXTRINE.
Corn Products Refining Co., New York City.
Stein, Hirsh & Co., New York City.

DIES.
Keller Pneumatic Tool Co., Grand Haven, Mich.

DIES (Cold Heading).
Keller Pneumatic Tool Co., Grand Haven, Mich.

DIGGING MACHINERY.
Hayward Co., The, New York City.

DISCS (Grinding).
Carborundum Co., Niagara Falls, N. Y.

DRAW SCREWS (For Wood and Iron Patterns).
Brown Specialty Machy. Co., Chicago, Ill.

DRESSERS (Grinding Wheel).
Norton Co., Worcester, Mass.

DRILLS (Electric).
Independent Pneumatic Tool Co., Chicago, Ill.
Stow Mfg. Co., The, Binghamton, N. Y.

DRILLS (Pneumatic).
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.
Pittsburg Pneumatic Co., Canton, O.

DUST ARRESTING SYSTEMS.
Cleveland Blow Pipe & Mfg. Co., Cleveland.
Cleveland Nickel Works, Cleveland, O.
Hoevel Mfg. Corporation, New York City.
Knickerbocker Co., Jackson, Mich.
Macleod Company, The, Cincinnati, O.
Mott Sand-Blast Mfg. Co., Inc., New York.
Ohio Blower Co., The, Cleveland, O.
Pangborn Corporation, Hagerstown, Md.
Paxson, J. W., Co., Philadelphia, Pa.
Sly, W. W., Mfg. Co., Cleveland, O.
Tilghman-Brooksbank Sand Blast Co., Philadelphia, Pa.
Whiting Fdy. Equipment Co., Harvey, Ill.

DYNAMOS.
General Electric Co., Schenectady, N. Y.
General Platers' Supply Co., New York, N. Y.
Lincoln Electric Co., Cleveland, O.

ELECTRICAL EQUIPMENT.
Lincoln Electric Co., Cleveland, O.

ELECTRIC ARC EQUIPMENT (For Cutting and Welding).
Lincoln Electric Co., Cleveland, O.

ELECTRIC BUCKETS.
Federal Malleable Co., West Allis, Wis.

ELECTRIC GENERATING SETS.
General Electric Co., Schenectady, N. Y.

ELEVATORS.
Ridgway, Craig, & Son, Coatesville, Pa.

ELEVATORS (Electric).
Whiting Fdy. Equipment Co., Harvey, Ill.

ELEVATORS, AUTOMATIC (Gravity).
Mathews Gravity Carrier Co., Ellwood City, Pa.

ELEVATORS (Pneumatic).
Curtis Pneumatic Machy. Co., St. Louis, Mo.
Whiting Fdy. Equipment Co., Harvey, Ill.

EMERY GRAIN (For Polishing).
General Platers' Supply Co., New York, N. Y.
Hampden Corundum Wheel Co., Brightwood, Springfield, Mass.

EMERY GRINDERS.
Hampden Corundum Wheel Co., Brightwood, Springfield, Mass.
Safety Emery Wheel Co., Springfield, O.
Sterling Grinding Wheel Co., Tiffin, O.

ENGINES (Steam).
Clarage Fan Co., Kalamazoo, Mich.

ENGINEERS (Consulting).
Chase, Frank D., Chicago, Ill.
Co-operative Engineering Co., Inc., New York.
General Briquetting Co., New York City.
Moore & Co., W. E., Pittsburgh, Pa.
Tropenas Converter Co., Brooklyn, N. Y.

ENGINEERS (Efficiency).
Kawin, Chas. C., Co., Chicago, Ill.

ENGINEERS (Foundry, Mechanical, Electrical, etc.).
Chase, Frank D., Chicago, Ill.
Detroit Testing Laboratory, Detroit, Mich.
General Briquetting Co., New York City.
Hooper-Falkenau Eng. Co., New York, N. Y.
Kawin, Chas. C., Co., Chicago, Ill.
Midland Machine Co., Detroit, Mich.
Sly, W. W., Mfg. Co., Cleveland, O.
Standard Sand & Machine Co., Cleveland, O.
Tropenas Converter Co., Brooklyn, N. Y.

ENGINEERS AND CONTRACTORS.
Chase, Frank D., Chicago, Ill.
General Briquetting Co., New York City.
Hooper-Falkenau Engineering Co., New York.

EXCAVATING MACHINERY.
Hayward Co., The, New York, N. Y.

EXHAUST SYSTEMS.
Hoevel Mfg. Corporation, New York City.
Illinois Mfg. & Supply Co., Quincy, Ill.
Pangborn Corporation, Hagerstown, Md.
Sly, W. W., Mfg. Co., Cleveland, O.
Tilghman-Brooksbank Sand Blast Co., Philadelphia, Pa

EXHAUSTERS (Gas).
Connersville Blower Co., Connersville, Ind.
Roots, P. H., & F. M., Co., Connersville, Ind.

EYE PROTECTORS.
King, Julius, Optical Co., New York City.
McCormick, J. S., Co., Pittsburgh, Pa.
Strong, Kennard & Nutt Co. ,Cleveland, O.

FACINGS.
Asbury Graphite Mills, Asbury, Warren County, N. J.
Bloomsbury Graphite Co., Bloomsbury, N. J.
Dixon, Jos., Crucible Co., Jersey City, N. J.
Federal Foundry Supply Co., Cleveland, O.
Hill-Brunner Fdy. Supply Co., Cincinnati, O.
Hill & Griffith Co., Cincinnati, O.
International Pulp Co., New York City.
Kelly, T. P., & Co., Inc., New York City.
McCormick, J. S., Co., Pittsburgh, Pa.
Obermayer, S., Co., Chicago, Ill.
Paxson, J. W., Co., Philadelphia, Pa.
Pettinos Brothers, New York City.
Stevens, Frederic B., Detroit, Mich.
U. S. Graphite Co., Saginaw, Mich.
Wedron Silica Co., Ottawa, Ill.
Woodison, The E. J., Co., Detroit, Mich.

FACING SAND MIXERS.
Sand Mixing Mch. Co., New York City.

FANS.
Clarage Fan Co., Kalamazoo, Mich.
Illinois Mfg. & Supply Co., Quincy, Ill.

FERRO-ALLOYS.
Blackwell, Geo., Sons & Co., Ltd., Liverpool, England.
Canada Carbide Sales Co., New York City.
Goldschmidt Thermit Co., New York City.
Lavino, E. J., & Co., Philadelphia, Pa.
Paxson, J. W., Co., Philadelphia, Pa.
U. S. Alloys Corp., New York.

FERRO CARBON-TITANIUM.
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

FERRO-CHROMIUM OR CHROMIUM.
Goldschmidt Thermit Co., New York City.
Lavino, E. J., & Co., Philadelphia, Pa.

FERRO-MANGANESE.
Foundry Manganese Co., Philadelphia, Pa.
Lavino, E. J., & Co., Philadelphia, Pa.

FERRO-MOLYBDENUM.
Primos Chemical Co., Primos, Pa.

FERRO-SILICON.
Canada Carbide Sales Co., New York City.
Foundry Manganese Co., Philadelphia, Pa.
Goldschmidt Thermit Co., New York, N. Y.
Lavino, E. J., & Co., Philadelphia, Pa.
U. S. Alloys Corp., New York.

FERRO-TITANIUM.
Goldschmidt Thermit Co., New York, N. Y.
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

FERRO-TUNGSTEN OR TUNGSTEN.
Goldschmidt Thermit Co., New York City.
Primos Chemical Co., Primos, Pa.

Linde Service—to Those Entitled to It

THE requirements of Oxygen users in a certain section of our country recently increased some six hundred per cent in four months.

Linde Service met that situation by planning and rushing to completion two brand new manufacturing units in that district and by filling all orders in the meantime through relief shipments of cylinders from other warehouse stations in the Linde coast to coast chain of sixty-four links.

The extra cost to us for freight on these reshipments averaged over ten thousand dollars per month for the period mentioned.

The significance of this instance will be apparent to all users of Oxygen who appreciate the value and importance of sure and certain deliveries under the shifting business conditions of these uncertain times.

The Linde Air Products Company

42nd Street Building, New York City, N. Y.

"Largest Producers of Oxygen in the World"

Orders Filled Day Received from Following Plants and Distributing Warehouses

- ALABAMA
  - Birmingham (Plant)
- COLORADO
  - Denver
- DISTRICT OF COLUMBIA
  - Washington
- GEORGIA
  - Atlanta (Plant)
  - Savannah
- ILLINOIS
  - Chicago (Plant)
  - Chicago (North Side)
  - East St. Louis
- INDIANA
  - East Chicago (Plant)
  - Fort Wayne
  - Indianapolis (Plant)
- IOWA
  - Davenport
  - Des Moines
- KANSAS
  - Wichita
- KENTUCKY
  - Louisville
- LOUISIANA
  - New Orleans
- MARYLAND
  - Baltimore (Plant)
- MASSACHUSETTS
  - Cambridge
  - Springfield
  - Worcester (Plant)
- MICHIGAN
  - Detroit (Plant)
  - Grand Rapids
- MINNESOTA
  - Duluth
  - Minneapolis (Plant)
- MISSOURI
  - No. Kansas City (Plant)
  - St. Louis
- NEBRASKA
  - Omaha
- NEW JERSEY
  - Elizabeth (Plant)
  - Newark
- NEW YORK
  - Albany
  - Brooklyn (Plant)
  - Buffalo
  - New York City
  - New York City (Bronx)
  - Utica (Plant)
- OHIO
  - Cleveland (Plant)
  - Cincinnati (Plant)
  - Columbus
  - Dayton
  - Lima
  - Toledo
  - Youngstown
- OKLAHOMA
  - Oklahoma City
  - Tulsa
- PENNSYLVANIA
  - Erie
  - Norristown (Plant)
  - No. Philadelphia (Plant)
  - Pittsburgh
  - Trafford
- TENNESSEE
  - Chattanooga
  - Memphis
- VIRGINIA
  - Richmond
- WISCONSIN
  - Manitowoc
  - Milwaukee (Plant)
- CALIFORNIA
  - Emeryville, Oakland (Plant)
  - Los Angeles (Plant)
- OREGON
  - Portland
- UTAH
  - Salt Lake City
- WASHINGTON
  - Seattle
  - Spokane
- TEXAS
  - Dallas (Plant)
  - Houston
  - San Antonio

3

FERRO-VANADIUM.
Goldschmidt Thermit Co., New York City.
Primos Chemical Co., Primos, Pa.

FILLERS (Metallic).
Clark Cast Steel Cement Co., Shelton, Conn.
Smooth-On Mfg. Co., Jersey City, N. J.

FILLET (Leather).
Paxson, J. W., Co., Philadelphia, Pa.

FIRE BRICK AND CLAY.
Columbian Facing Mills Co., Buffalo, N. Y.
Combined Supply & Equip't Co., Buffalo, N. Y.
Gautier, J. H., & Co., Jersey City, N. J.
Hoosier Clay Products Co., Hillsdale, Ind.
Illinois Clay Products Co., Oglesby, Ill.
Keener Sand & Clay Co., The, Columbus, O.
Maurer, Henry, & Sons, New York, N. Y.
Paxson, J. W., Co., Philadelphia, Pa.
Peekskill Fire Brick Works, Inc., Peekskill, N. Y.
Stevens, Frederic B., Detroit, Mich.
Wagner Fire Brick Co., Scranton, Pa.
Whitehead Bros. Co., New York, N. Y.
Woodison, E. J., Detroit, Mich.

FIREPROOF CLOTHING.
Wheeler & Holcomb Co., Chicago.

FIRE SAND.
Carborundum Co., Niagara Falls, N. Y.
Paxson, J. W., Co., Philadelphia, Pa.
Pettinos Bros., New York City.
Whitehead Brothers Co., Providence, R. I.

FIXTURES.
Keller Pneumatic Tool Co., Grand Haven, Mich.

FLASK LUMBER.
Coale, Thomas E., Lumber Co., Philadelphia.
Smith, Fassett & Co., N. Tonawanda, N. Y.

FLASKS.
Adams Co., Dubuque, Iowa.
Arcade Mfg. Company, Freeport, Ill.
Barnett, Oscar, Fdy. Co., Irvington, N. J.
Berkshire Mfg. Co., Cleveland.
Diamond Clamp & Flask Co., Richmond, Ind.
Sterling Wheelbarrow Co., Milwaukee, Wis.
U. S. Molding Machine Co., Cleveland.

FLASKS (Iron).
Barnett, Oscar, Fdy. Co., Irvington, N. J.
Berkshire Mfg. Co., Cleveland.

FLASKS (Snap).
Adams Co., Dubuque, Iowa.
Arcade Mfg. Company, Freeport, Ill.
Berkshire Mfg. Co., Cleveland, O.
Diamond Clamp & Flask Co., Richmond, Ind.
Hill-Brunner Fdy. Supply Co., Cincinnati, O.
Hill & Griffith Co., The, Cincinnati, O.
Obermayer, S., Co., Chicago, Ill.
Paxson, J. W., Co., Philadelphia, Pa.
Sterling Wheelbarrow Co., Milwaukee, Wis.
Tabor Mfg. Co., Philadelphia, Pa.
Wood, T. B., Sons Co., Chambersburg, Pa.

FLOUR (Foundry).
Paxson, J. W., Co., Philadelphia, Pa.

FLUOR SPAR.
Paxson, J. W., Co., Philadelphia, Pa.
Rogers, Brown & Co., Cincinnati, O.

FLUX (For Iron or Brass).
Basic Mineral Co., Pittsburgh, Pa.
Buckeye Products Co., Cincinnati, O.
Paxson, J. W., Co., Philadelphia, Pa.

FOOT PROTECTORS.
Horstmann, Wm. H., Co., Philadelphia, Pa.

FOUNDRY EQUIPMENT.
American Fdy. Equip. Co., Cleveland, O.
Arcade Mfg. Company, Freeport, Ill.
Barnett, Oscar, Fdy. Co., Irvington, N. J.
Biehl Iron Works, The, Inc., Reading, Pa.
Brown Specialty Machy. Co., Chicago, Ill.
Central Fdy. Supply Co., Columbus, O.
Chesapeake Iron Works, Baltimore, Md.
Combined Supply & Equip't Co., Buffalo, N. Y.
Davenport Machine & Foundry Co., Davenport, Iowa.
Foundry Equipment Co., The, Cleveland, O.
Hill-Brunner Fdy. Supply Co., Cincinnati, O.
Hill & Griffith Co., Cincinnati, O.
Hoevel Mfg. Corporation, New York City.
Illinois Mfg. & Supply Co., Quincy, Ill.
International Molding Machine Co., Chicago, Ill.
McCormick, J. S., Co., Pittsburgh, Pa.
Monarch Eng. & Mfg. Co., Baltimore, Md.
Mott Sand-Blast Mfg. Co., Inc., New York.
Mumford, E. H., Co., Elizabeth, N. J.
Mumford Molding Mch. Co., Chicago, Ill.
National Engrg. Co., Chicago, Ill.
Northern Engineering Works, Detroit, Mich.
Obermayer, S., Co., Chicago, Ill.
Paxson, J. W., Co., Philadelphia, Pa.
Peck Iron & Steel Co., Kalmazoo, Mich.
Pridmore, Henry E., Chicago, Ill.
Sand Mixing Mach. Co., New York City.
Scully-Jones & Co., Chicago, Ill.
Sly, W. W., Mfg. Co., Cleveland, O.
Standard Sand & Machine Co., Cleveland, O.
Stevens, Frederic B., Detroit, Mich.
Tabor Mfg. Co., Philadelphia, Pa.
U. S. Molding Mach. Co., Cleveland, O.
Whiting Fdy. Equipment Co., Harvey, Ill.
Wonham, Bates & Goode, Inc., New York.
Wood, T. B., Sons Co., Chambersburg, Pa.

FOUNDRY EQUIPMENT (Second Hand).
Adams, J. W., Philadelphia, Pa.
Clifton-Pratt Co., The, Cincinnati, O.
Federal Fdry. Supply Co., The, Cleveland, O.
Harris Brothers Co., Chicago, Ill.
McCormick, J. S., Co., Pittsburgh, Pa.
Scully-Jones & Co., Chicago, Ill.

FOUNDRY SPECIALISTS.
Kawin, Chas. C., Co., Chicago, Ill.
McLain's System, Inc., Milwaukee, Wis.
Sly, W. W., Mfg. Co., Cleveland, O.

FOUNDRY SUPPLIES.
Birkenstein & Sons, S., Chicago, Ill.
Bloomsbury Graphite Co., Bloomsbury, N. J.
Central Fdy. Supply Co., Columbus, O.
Columbian Facing Mills Co., Buffalo, N. Y.
Combined Supply & Equip't Co., Buffalo, N. Y.
Demmler, Wm., & Bros., Kewanee, Ill.
Federal Foundry Supply Co., Cleveland, O.
Hill-Brunner Fdy. Supply Co., Cincinnati, O.
Hill & Griffith Co., Cincinnati, O.
International Pulp Co., New York City.
Kelly, T. P., & Co., Inc., New York City.
McCormick, J. S., Co., Pittsburgh, Pa.
Mott Sand-Blast Mfg. Co., Inc., New York.
Obermayer, S., Co., Chicago, Ill.
Osborn Mfg. Co., Cleveland, O.
Paxson, J. W., Co., Philadelphia, Pa.
Pettinos Brothers, New York City.
Sly, W. W., Mfg. Co., Cleveland, O.
Stevens, Frederic B., Detroit, Mich.
U. S. Chaplet & Supply Co., New York City.
Whitehead Bros. Co., New York, N. Y.
Woodison, E. J., Co., The, Detroit, Mich.
Woods', T. B., Sons Co., Chambersburg, Pa.

FURNACE LININGS.
Carborundum Co., Niagara Falls, N. Y.
Hawley Down Draft Furnace Co., Easton, Pa.
Iler Company, The, Cleveland, O.
Quigley Furnace Specialties Co., New York.

FURNACE LININGS (Graphite).
Dixon, Joseph, Crucible Co., Jersey City, N. J.

FURNACES.
Foundry Equipment Co., Cleveland.
Buckeye Products Co., Cincinnati, O.
Hawley Down Draft Furnace Co., Easton, Pa.
Monarch Eng. & Mfg. Co., Baltimore, Md.

FURNACES (Aluminum).
American Foundry Equip't Co., Cleveland, O.
Foundry Equipment Co., Cleveland.
Hawley Down Draft Furnace Co., Easton, Pa.
Iler Company, The, Cleveland, O.
Monarch Eng. & Mfg. Co., Baltimore, Md.

FURNACES (Annealing).
Monarch Eng. & Mfg. Co., Baltimore, Md.

FURNACES (Brass).
Central Fdy. Supply Co., Columbus, O.
Foundry Equipment Co., Cleveland, O.
Hawley Down Draft Furnace Co., Easton, Pa.
Iler Company, The, Cleveland, O.
Monarch Eng. & Mfg. Co., Baltimore, Md.
Paxson, J. W., Co., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.
Whiting Fdy. Equipment Co., Harvey, Ill.
Woodison, E. J., Co., The, Detroit, Mich.

FURNACES (Case Hardening).
Monarch Eng. & Mfg. Co., Baltimore, Md.

FURNACES (Crucible Steel).
Hawley Down Draft Furnace Co., Easton, Pa.
Monarch Eng. & Mfg. Co., Baltimore, Md.
Natural Draft Oil Furnace Co., New York.
Whiting Fdy. Equipment Co., Harvey, Ill.

FURNACES (Electric).
Greene, The Albert E., Co., Seattle, Wash.
Industrial Electric Furnace Co., Chicago.
Ludlum Electric Furnace Corp., New York.

FURNACES (Galvanizing).
Monarch Eng. & Mfg. Co., Baltimore, Md.

FURNACES (Malleable Iron).
Whiting Fdy. Equipment Co., Harvey, Ill.

FURNACES (Melting).
Barnett, Oscar, Fdy. Co., Irvington, N. J.
Foundry Equipment Co., Cleveland.
Hamilton & Hansell, New York City.
Hawley Down Draft Furnace Co., Easton, Pa.
Industrial Electric Furnace Co., Chicago.
Iler Company, The, Cleveland, O.
McLain's System, Milwaukee, Wis.
Monarch Eng. & Mfg. Co., Baltimore, Md.

FURNACES (Oil).
American Fdy. Equipment Co., Cleveland, O.
Foundry Equipment Co., Cleveland.
Hawley Down Draft Furnace Co., Easton, Pa.
Iler Company, The, Cleveland, O.
Macleod Company, The, Cincinnati, O.
National Draft Oil Furnace Co., New York.
Monarch Eng. & Mfg. Co., Baltimore, Md.

FURNACES (Open Hearth).
McLain's System, Inc., Milwaukee, Wis.

GAGGER MOLDS (Air Cooled).
Wadsworth Core Mch. & Equipment Co., Akron, O.

GAS BOOSTERS (Rotary).
Roots, P. H., & F. M., Co., Connersville, Ind.

GAS EXHAUSTERS (Rotary, Positive Pressure).
Roots, P. H. & F. M., Co., Connersville, Ind.

GAS PUMPS (Rotary, Positive Pressure).
Roots, P. H. & F. M., Co., Connersville, Ind.

GAGES.
Keller Pneumatic Tool Co., Grand Haven, Mich.

GEAR HOBBERS.
Adams Company, The, Dubuque, Ia.

GEARING.
Dunning, W. D., Syracuse, N. Y.

GEARS (Silent).
General Electric Co., Schenectady, N. Y.

GENERATORS (Direct and Alternating).
Lincoln Electric Co., Cleveland, O.

GENERATORS (Oxy-Acetylene, Oxygen, Hydrogen).
Davis-Bournonville Co., Jersey City, N. J.
Linde Air Products Co., Chicago, Ill.
Milburn, The Alexander, Co., Baltimore, Md.
Oxweld Acetylene Co., Chicago, Ill.
Prest-O-Lite Co., Indianapolis, Ind.

GIRDERS (Steel).
Peck Iron & Steel Co., Kalamazoo, Mich.

GLOVES (Sand Blast).
Mott Sand-Blast Mfg. Co., Inc., New York.
Pangborn Corporation, Hagerstown, Md.
Paxson, J. W., Co., Philadelphia, Pa.

GLOVES AND MITTS (Asbestos).
Wheeler & Holcomb Co., Chicago.

GLUCOSE.
Corn Products Refining Co., New York City.

GOGGLES.
King, Julius, Optical Co., New York City.
Paxson, J. W., Co., Philadelphia, Pa.
Strong-Kennard & Nutt Co., Cleveland, O.

GRAPHITE.
Asbury Graphite Mills, Asbury, Warren Co., N. J.
Bloomsbury Graphite Co., Bloomsbury, N. J.
Hill-Brunner Fdy. Supply Co., Cincinnati, O.
Hill & Griffith Co., The, Cincinnati, O.
Kelly, T. P., & Co., Inc., New York City.
Obermayer, S., Co., Chicago, Ill.
Paxson, J. W., Co., Philadelphia, Pa.
Pettinos Brothers, New York City.

GRAPHITE (Boiler and Lubricating).
Asbury Graphite Mills, Asbury, Warren Co., N. J.
U. S. Graphite Co., Saginaw, Mich.

GREASES.
Cataract Refining & Mfg. Co., Buffalo, N. Y.
Swan & Finch Co., New York.
U. S. Graphite Co., Saginaw, Mich.

GRINDERS (Electric).
Independent Pneumatic Tool Co., Chicago, Ill.

GRINDERS (Pneumatic Portable).
Cleveland Pneumatic Tool Co., Cleveland, O.
Dayton Pneumatic Tool Co., Dayton, O.
Independent Pneumatic Tool Co., Chicago, Ill.
Safety Emery Wheel Co., Springfield, O.

GRINDERS (Snagging).
Blount, J. G., Everett, Mass.

GRINDING PANS.
American Clay Machy. Co., The, Bucyrus, O.
International Clay Machinery Co., Dayton, O.
Phillips & McLaren Co., Pittsburgh, Pa.
Tropenas Converter Co., Brooklyn, N. Y.

GRINDING TOOLS.
Safety Emery Wheel Co., Springfield, O.
Sterling Grinding Wheel Co., Tiffin, O.
Stow Mfg. Co., Binghamton, N. Y.

GRINDING WHEELS AND MACHINERY.
Abrasive Co., Bridesburg, Philadelphia, Pa.
Adams Co., Dubuque, Ia.
Blount, J. G., Co., Everett, Mass.
Chicago Pneumatic Tool Co., Chicago, Ill.
Hampden Corundum Wheel Co., Brightwood, Springfield, Mass.
Norton Co., Worcester, Mass.
Paxson, J. W., Co., Philadelphia, Pa.
Safety Emery Wheel Co., Springfield, O.
Sterling Grinding Wheel Co., Tiffin, O.
Worthington Pump & Mchy. Corp., New York.

GRINDING WHEEL PLATES (Steel).
Moltrup Steel Products Co., Beaver Falls, Pa.

Everybody Knows "The Pennsy"

Last words in Railroading are spoken by "Pennsy."

Vice-President Atterbury was the man Uncle Sam sent to France to show them how.

"The Pennsy" employs Real Engineers.

The fellows who start in by dragging the chain and driving stakes come up by virtue of Brains and not by virtue of Pull or "Papa" or "Uncle George."

And so when the Pennsylvania Railroad want elevators, of course they **"HOOK 'ER TO THE BILER."** Just ordered a lot more.

But a Great Man like you—

"Say, don't make me laff, I've got a split lip!"

See this bunch of Big Fellows, all happy Steam Hydraulickers:

United Gas Improvement Co.
Yale & Towne Mfg. Co.
Cluett, Peabody & Co.
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General Electric Co.
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Now just think of any "Dead One" calling himself an "engineer"—yea, a "Consulting Engineer, at that" putting electrical elevators upon a confiding client.

Without finding out why **2000** of the greatest concerns in the land are so keen to

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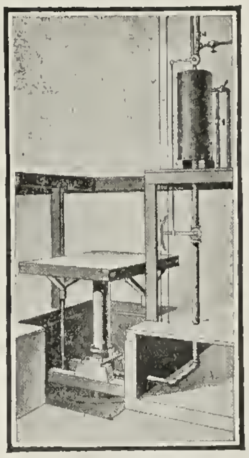

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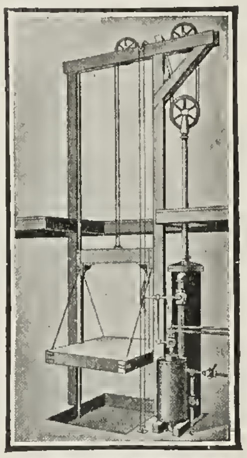

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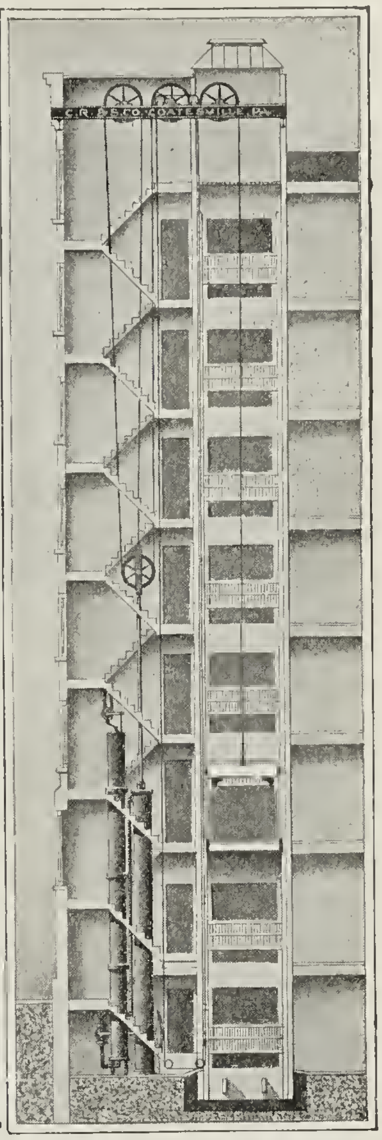

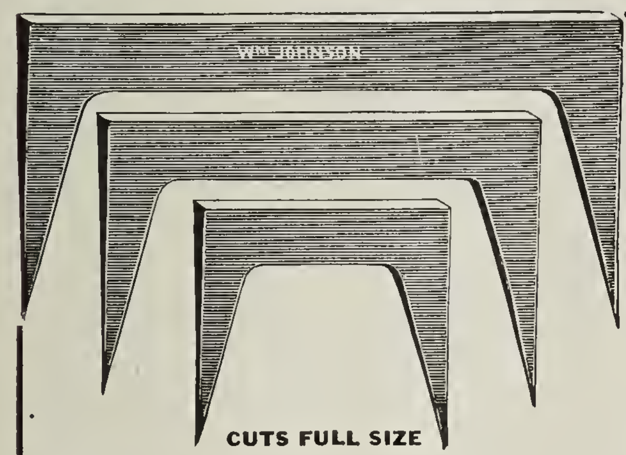

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Size Steel	3-16 in.	¼ in.	¼ in.	¼ in.	5-16 in.	5-16 in.	⅜ in.	7-16 in.	½ in. Square
Length	¾ in.	1 in.	1¼ in.	2 in.	2¾ in.	3 and 3½ in.	4 in.	5 in.	6 and 6½ in.
Price	$1.65	1.30	1.30	1.75	2.25	2.60	3.00	4.15	5.00 Net Doz.

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HELMETS (Sand Blast).
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Manning, Maxwell & Moore, Inc., New York.
Northern Engineering Works, Detroit, Mich.
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Scully-Jones & Co., Chicago, Ill.
Shaw Electric Crane Co., New York, N. Y.
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Mumford, E. H., Co., Elizabeth, N. J.
Mumford Molding Mach. Co., Chicago, Ill.
Osborn Mfg. Co., The, Cleveland, O.
Pridmore, Henry E., Chicago, Ill.
Tabor Mfg. Co., Philadelphia, Pa.
Woodison, The E. J., Co., Detroit, Mich.

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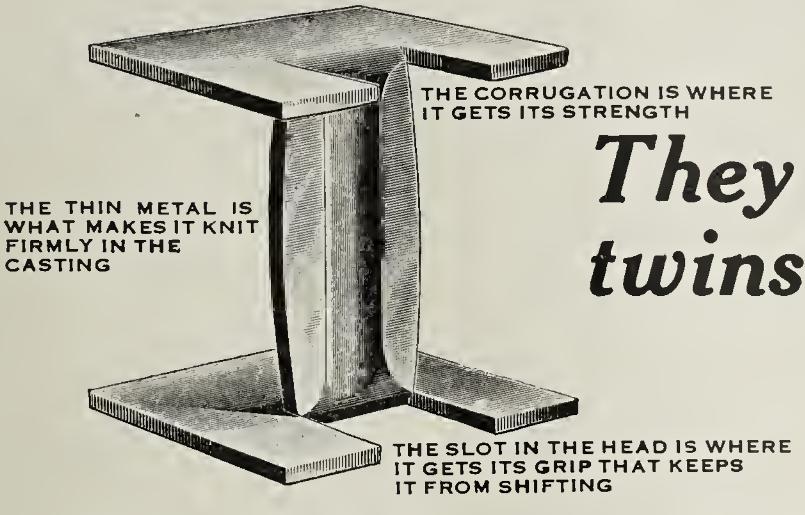
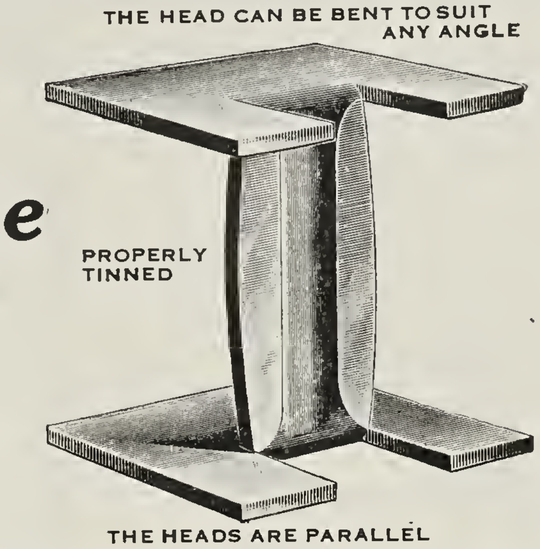

THE CORRUGATION IS WHERE IT GETS ITS STRENGTH
THE THIN METAL IS WHAT MAKES IT KNIT FIRMLY IN THE CASTING
THE SLOT IN THE HEAD IS WHERE IT GETS ITS GRIP THAT KEEPS IT FROM SHIFTING

They're twins!



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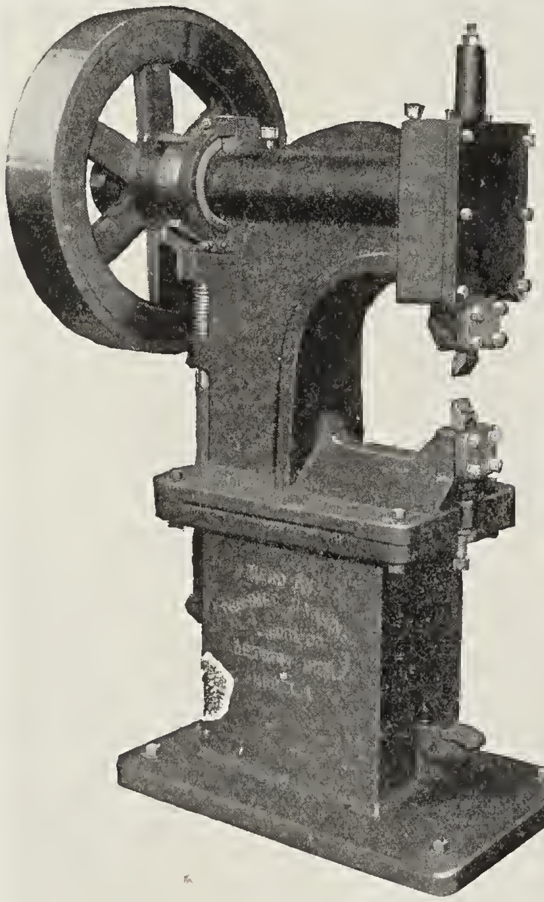

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Linde Air Products Co., Chicago, Ill.
Milburn, The Alexander Co., Baltimore, Md.
Oxweld Acetylene Co., Chicago, Ill.
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U. S. Graphite Co., Saginaw, Mich.

PANS (Grinding).
American Clay Machy. Co., The, Bucyrus, O.
Paxson, J. W., Co., Philadelphia, Pa.
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Hill & Griffith Co., The, Cincinnati, O.
Kelly, T. P., & Co., Inc., New York City.
Obermayer, S., Company, Chicago, Ill.
Paxson, J. W., Co., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.
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Hill & Griffith Co., The, Cincinnati, O.
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Coale, Thomas E., Lumber Co., Philadelphia.
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PATTERN PLATES.
Moltrup Steel Products Co., Beaver Falls, Pa.

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Bernstein Mfg. Co., Philadelphia, Pa.
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Corbett-Steeves Pattern Wks., Rochester, N. Y.
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Woodison, E. J., Co., The, Detroit, Mich.

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McKeefrey & Co., Leetonia, O.
Marshall, F. W., & Co., Philadelphia, Pa.
Mohr, J. J., & Son, Philadelphia, Pa.
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Pilling & Crane, Philadelphia, Pa.
Rogers, Brown & Co., Cincinnati, O.

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PLATES (Grinding Wheel Steel).
Moltrup Steel Products Co., Beaver Falls, Pa.

PLATES (Steel Pattern).
Moltrup Steel Products Co., Beaver Falls, Pa.

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McCullough-Dalzell Crucible Co., Pittsburgh.
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Paxson, J. W., Co., Philadelphia, Pa.
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Stevens, Frederic B., Detroit, Mich.
Woodison, E. J., Co., The, Detroit, Mich.

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Arcade Mfg. Co., Freeport, Ill.
Davenport Machine & Foundry Co., Davenport, Iowa.
Mumford, E. H., Co., Elizabeth, N. J.
Osborn Mfg. Co., The, Cleveland, O.
Tabor Mfg. Co., Philadelphia Pa.

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Quigley Furnace Specialties Co., New York.

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PROPELLER WHEELS.
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PULLEYS.
Dunning, W. D., Syracuse, N. Y.

PULVERIZERS.
Iler Company, The, Cleveland, O.

PUMPS.
Connersville Blower Co., The, Connersville, Ind.
Roots, P. H., & F. M., Co., Connersville, Ind.

PUMPS (Hydraulic).
Roots, P. H., & F. M., Co., Connersville, Ind.

PUMPS (Mine).
Roots, P. H., & F. M., Co., Connersville, Ind.

PUMPS (Oil and Tar).
Roots, P. H., & F. M., Co., Connersville, Ind.

PUMPS (Power).
Roots, P. H., & F. M., Co., Connersville, Ind.

PUMPS (Rotary Pressure).
Roots, P. H., & F. M., Co., Connersville, Ind.

PUMPS (Rotary Vacuumn).
Roots, P. H., & F. M., Co., Connersville, Ind.

PUMPS (Vacuum Filtration).
Roots, P. H., & F. M., Co., Connersville, Ind.

PYROSCOPES.
Shore Instrument & Mfg. Co., New York City.

RACKS (Steel).
Bernstein Mfg. Co., Philadelphia, Pa.

RAILWAY (Narrow Gauge).
Hunt, C. W., Co., Inc., West New Brighton, N. Y.

RESPIRATORS.
Mott Sand-Blast Co., Inc., New York.
Multi-Metal Separating Screen Co., New York City.

RHEOSTATS (Field and Battery Charging).
General Electric Co., Schenectady, N. Y.

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Federal Foundry Supply Co., Cleveland, O.
Great Western Mfg. Co., Leavenworth, Kan.
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Paxson, J. W., Co., Philadelphia, Pa.
Whitehead Bros. Co., New York, N. Y.

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Pittsburg Pneumatic Co., Canton, O.

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Asbestos Protected Metal Co., Pittsburgh, Pa.

ROOF PAINT.
Asbestos Protected Metal Co., Pittsburgh, Pa.

ROOFING AND SIDING (Asbestos).
Asbestos Protected Metal Co., Pittsburgh, Pa.

ROSIN.
Paxson, J. W., Co., Philadelphia, Pa.

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Wheeler & Holcomb Co., Chicago.

SAFETY GOGGLES.
King, Julius, Optical Co., New York City.

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Geauga Silica Sand Co., Cleveland, O.
Gordon Sand Co., The, Conneaut, O.
Keener Sand & Clay Co., The, Columbus, O.
Paxson, J. W., Co., Philadelphia, Pa.
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Superior Sand Co., Cleveland, O.
U. S. Silica Company, Chicago, Ill.
Wedron Silica Co., Ottawa, Ill.
Whitehead Bros., New York, N. Y.

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Harrison Supply Co., Boston, Mass.
Hoevel Mfg. Corporation, New York City.
Macleod Company, The, Cincinnati, O.
Mott Sand-Blast Mfg. Co., Inc., New York.
New Haven Sand Blast Co., New Haven, Ct.
Pangborn Corporation, Hagerstown, Md.
Paxson, J. W., Co., Philadelphia, Pa.
Pittsburgh Crushed Steel Co., Pittsburgh, Pa.
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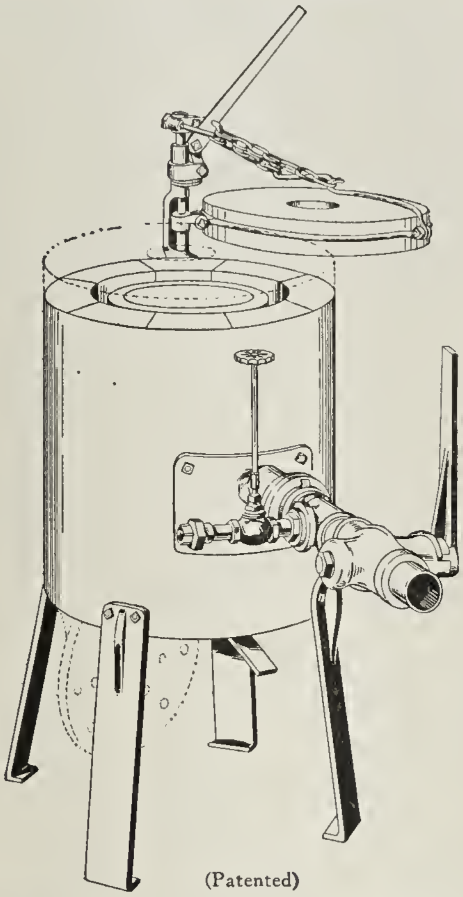

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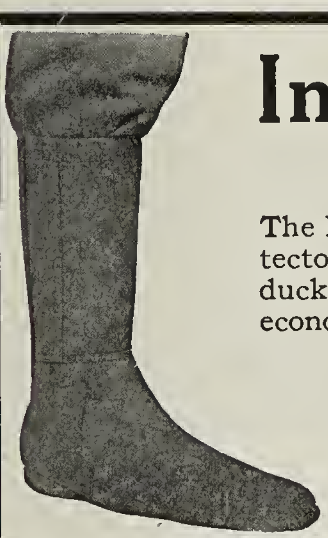

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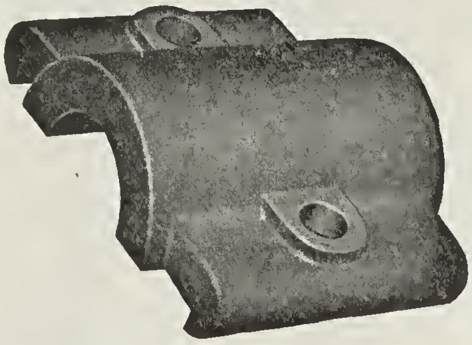

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U. S. Silica Co., Chicago, Ill.
Wedron Silica Co., Ottawa, Ill.

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New Haven Sand Blast Co., New Haven, Ct.
Pittsburgh Crushed Steel Co., Pittsburgh, Pa.

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Macleod Company, The, Cincinnati, O.
Mott Sand-Blast Mfg. Co., Inc., New York.
New Haven Sand Blast Co., New Haven, Ct.
Pangborn Corporation, Hagerstown, Md.
Paxson, J. W., Co., Philadelphia, Pa.
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Pangborn Corporation, Hagerstown, Md.
Tilghman-Brooksbank Sand Blast Co., Philadelphia, Pa.

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Frost Mfg. Co., The, Chicago, Ill.
Hall-Holmes Mfg. Co., Jackson, Mich.
McCormick, J. S., Co., Pittsburgh, Pa.
National Engrg. Co., Chicago, Ill.
Paxson, J. W., Co., Philadelphia, Pa.
Sand Mixing Machine Co., New York, N. Y.
Sellers Wm., & Co., Inc., Philadelphia, Pa.
Standard Sand & Machine Co., Cleveland, O.
Vulcan Engrg. Sales Co., Chicago, Ill.
Wadsworth Core Mch. & Equipment Co., Akron, O.
Wonham, Bates & Goode, Inc., New York.

SAND RAMMERS (Pneumatic).
Cleveland Pneumatic Tool Co., Cleveland, O.
Dayton Pneumatic Tool Co., Dayton, O.
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Oldham, Geo., & Son Co., Frankford, Philadelphia, Pa.
Pittsburgh Pneumatic Co., Canton, O.

SAND RECLAIMERS.
American Clay Machy. Co., The, Bucyrus, O.
National Engrg. Co., Chicago, Ill.

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Arcade Mfg. Co., Freeport, Ill.
Blystone Mfg. Co., Cambridge Springs, Pa.
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Champion Fdy. & Machine Co., Chicago, Ill.
Great Western Mfg. Co., Leavenworth, Kan.
Hall-Holmes Mfg. Co., Jackson, Mich.
Hanna Engrg. Works, Chicago, Ill.
Herman Pneumatic Mch. Co., Zelienople, Pa.
Keller Pneumatic Tool Co., Grand Haven, Mich.
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Paxson, J. W., Co., Philadelphia, Pa.
Standard Sand & Machine Co., Cleveland, O.
Worthington Pump & Mchy. Corp., New York.

SASH (Steel).
Lupton's, David, Sons Co., Philadelphia, Pa.

SAWS (Cold, Inserted Tooth).
Tabor Mfg. Co., Philadelphia, Pa.

SAWS (Cold Metal).
Q. M. S. Co., The, Chicago, Ill.
Tabor Mfg. Co., Philadelphia, Pa.

SCIENTIFIC MELTING.
McLain's System, Inc., Milwaukee, Wis.

SCLEROSCOPES.
Shore Instrument & Mfg. Co., New York City.

SCRAP-RENEWING METAL ALLOYS.
American Boron Products Co., Reading, Pa.

SCREENING MACHINERY.
National Engrg. Co., Chicago, Ill.

SCREENS (Sand).
Standard Sand & Machine Co., Cleveland, O.

SEACOAL.
Bloomsbury Graphite Co., Bloomsbury, N. J.
Federal Foundry Supply Co., Cleveland, O.
Hill-Brunner Fdy. Supply Co., Cincinnati, O.
Kelly, T. P., & Co., Inc., New York City.
Obermayer, S., Co., Chicago, Ill.
McCormick, J. S., Co., Pittsburgh, Pa.
Paxson, J. W., Co., Philadelphia, Pa.
Stevens, Frederic B., Detroit, Mich.
Whitehead Bros. Co., New York, N. Y.

SEMI-STEEL.
McLain's System, Inc., Milwaukee, Wis.

SEPARATORS (Magnetic).
Dings Magnetic Separator Co., Milwaukee, Wis.
Magnetic Mfg. Co., Milwaukee, Wis.
Paxson, J. W., Co., Philadelphia, Pa.

SEPARATORS (Moisture—Oil).
Pangborn Corporation, Hagerstown, Md.

SEPARATORS (Sand).
Pangborn Corporation, Hagerstown, Md.

SHAFTING.
Dunning, W. D., Syracuse, N. Y.
Stow Mfg. Co., Binghamton, N. Y.

SHEET METAL STAMPINGS.
U. S. Chaplet & Supply Co., New York City.

SHEETS (Corrugated, Beaded and Flat).
Asbestos Protected Metal Co., Pittsburgh, Pa.

SHELL CHAPLETS.
U. S. Chaplet & Supply Co., New York City.

SHELVING (Steel).
Bernstein Mfg. Co., Philadelphia, Pa.

SHIP FITTINGS.
Scranton Foundry & Engine Works, Inc., New York City.

SHIP FRAMING WORK.
Scranton Foundry & Engine Works, New York City.

SHOES (Molders').
Brennan Boot & Shoe Co., Natick, Mass.

SHOT (Steel).
Harrison Supply Co., Boston, Mass.
Mott Sand-Blast Mfg. Co., Inc., New York.
Pittsburgh Crushed Steel Co., Pittsburgh, Pa.

SHOVELS.
Hill-Brunner Fdy. Supply Co., Cincinnati, O.
Hill & Griffith Co., The, Cincinnati, O.
Obermayer, S., Co., Chicago, Ill.
Osborn Mfg. Co., Cleveland, O.
Paxson, J. W., Co., Philadelphia, Pa.
Pittsburgh Shovel Co., Pittsburgh, Pa.
Whitehead Bros. Co., New York, N. Y.

SHOWER BATHS.
Cleveland Blow Pipe & Mfg. Co., Cleveland.

SILICA (Ground and Grits).
Paxson, J. W., Co., Philadelphia, Pa.
Portage Silica Company, Youngstown, O.
U. S. Silica Company, Chicago, Ill.

SKIMMERS.
Paxson, J. W., Co., Philadelphia, Pa.

SKIN DRYING TORCHES.
Paxson, J. W., Co., Philadelphia, Pa.

SKYLIGHT (Rolled Steel).
Lupton's, David, Sons Co., Philadelphia, Pa.

SKYLIGHT BARS.
Asbestos Protected Metal Co., Pittsburgh, Pa.

SLIP JACKETS (Steel).
Diamond Clamp & Flask Co., Richmond, Ind.
Federal Foundry Supply Co., Cleveland, O.

SMOKE CONDENSERS.
Hawley Down Draft Furnace Co., Easton, Pa.

SNAP FLASK BOTTOM PLATES.
Diamond Clamp & Flask Co., Richmond, Ind.
Wadsworth Core Mch. & Equip. Co., Akron, O.

SNAP FLASK TRIMMINGS.
Adams Company, The, Dubuque, Ia.
Diamond Clamp & Flask Co., Richmond, Ind.

SNAP MOLD JACKET.
Diamond Clamp & Flask Co., Richmond, Ind.
Woods, T. B., Sons Co., Chambersburgh, Pa.

SOAPSTONE (Red and Yellow).
Hill-Brunner Fdy. Supply Co., Cincinnati, O.

SPADES.
Pittsburgh Shovel Co., Pittsburgh, Pa.

SPARK ARRESTERS.
Paxson, J. W., Co., Philadelphia, Pa.

SPELTER.
American Zinc, Lead & Smelting Co., Boston.
New Jersey Zinc Co., New York City.
Wenger, Paul, & Co., New York City.

SPIEGELEISEN.
New Jersey Zinc Co., New York City.

SPIRAL CHUTES.
Mathews Gravity Carrier Co., Ellwood City, Pa.

SPLIT PATTERN MACHINES.
Mumford, E. H., Co., Elizabeth, N. J.
Tabor Mfg. Company, Philadelphia, Pa.

SPRINGS (Vanadium).
Barnett, Oscar, Foundry Co., Irvington, N. J.

SPRUE CUTTERS.
Arcade Mfg. Co., Freeport, Ill.
Barnett, Oscar, Foundry Co., Irvington, N. J.
Foundry Equipment Co., Cleveland.
Paxson, J. W., Co., Philadelphia, Pa.
Shuster, F. B., Co., New Haven, Conn.
Tessmer Mch. & Tool Co., Detroit, Mich.
Vulcan Engineering Sales Co., Chicago, Ill.

SPRUES (Spring).
Malleable Iron Fittings Co., Branford, Conn.

SQUEEZERS (Hand).
Arcade Mfg. Company, Freeport, Ill.
Cooper, H. W., Saddlery Hardware Mfg. Co., Moline, Ill.
Davenport Mch. & Fdy. Co., Davenport, Ia.
Federal Malleable Co., West Allis, Wis.
Foundry Equipment Co., Cleveland.
Mumford Molding Machine Co., Chicago, Ill.
Osborn Mfg. Co., The, Cleveland, O.
Pridmore, Henry E., Chicago, Ill.
Tabor Mfg. Co., Philadelphia, Pa.

STACKS (Steel).
Peck Iron & Steel Co., Kalamazoo, Mich.

STARCH.
Corn Products Refining Co., New York City.

STARS.
Cleveland Nickel Works, Cleveland, O.

STARS (Hard Iron).
Fanner Mfg. Co., The, Cleveland, O.

STARTERS (Electric Motor).
General Electric Co., Schenectady, N. Y.
Lincoln Electric Co., Cleveland, O.

STEAM SPECIALTIES.
Ohio Blower Co., The, Cleveland, O.

STEAM TURBINE BLADES (Steel).
Moltrup Steel Products Co., Beaver Falls, Pa.

STEEL.
McLain's System, Inc., Milwaukee, Wis.

STEEL (Sash).
Lupton's, David, Sons Co., Philadelphia, Pa.

STEEL BANDS.
Diamond Clamp & Flask Co., Richmond, Ind.
Peck Iron & Steel Co., Kalamazoo, Mich.

STEEL FACTORY EQUIPMENT.
Bernstein Mfg. Co., Philadelphia, Pa.

STEEL FIRE BRICK.
Woodison, E. J., Co., Detroit, Mich.

STEEL GRIT.
Harrison Supply Co., Boston, Mass.
Pittsburgh Crushed Steel Co., Pittsburgh.

STEEL PRODUCTS (Cold Drawn).
Moltrup Steel Products Co., Beaver Falls, Pa.

STEEL SASH.
Lupton's, David, Sons Co., Philadelphia, Pa.

STONES (Oil).
Carborundum Co., Niagara Falls, N. Y.
Norton Co., Worcester, Mass.

STONES (Rubbing and Sharpening).
Hampden Corundum Wheel Co., Brightwood, Springfield, Mass.
Norton Co., Worcester, Mass.

STOOLS AND CHAIRS.
Manufacturing Equipment & Engrg. Co., Framingham, Mass.

STOPPERS.
Gautier, J. H., & Co., Jersey City, N. J.
McCullough-Dalzell Crucible Co., Pittsburgh.

STOVE LINING.
Peekskill Fire Brick Works, Inc., Peekskill, N. Y.

STOVE SPECIALTIES (Tin).
U. S. Chaplet & Supply Co., New York City.

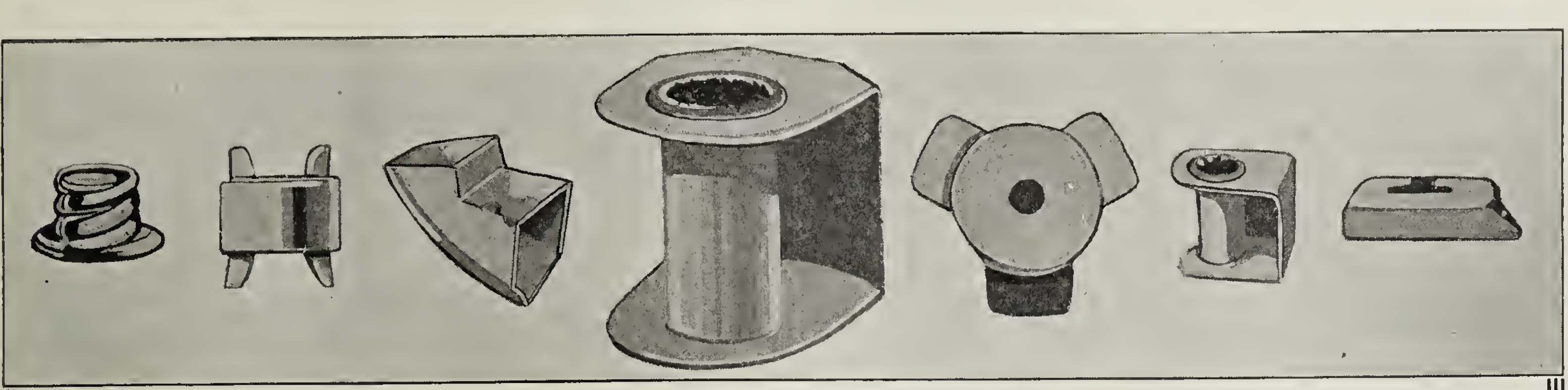
STOVE TRIMMINGS.
Fanner Mfg. Co., The, Cleveland, O.

STRUCTURAL IRON WORK.
Dunning, W. D., Syracuse, N. Y.
Sly, W. W., Mfg. Co., Cleveland, O.

STRUCTURAL STEEL.
Chesapeake Iron Works, Baltimore, Md.
Peck Iron & Steel Co., Kalamazoo, Mich.

SULPHURIC ACID.
American Zinc, Lead & Smelting Co., Boston.
New Jersey Zinc Co., New York City.

See Index to Advertisements for pages containing advertisements of companies listed above



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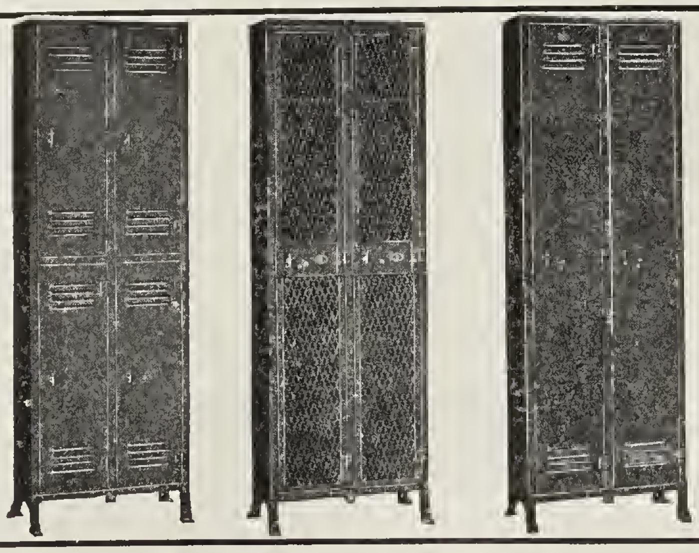


SWITCHES (Electrical).
General Electric Co., Schenectady, N. Y.
Lincoln Electric Co., Cleveland, O.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

TABLES (Rotary Sand Blast).
Amer. Fdy. Equipment Co., Cleveland, O.
Hoevel Mfg. Corporation, New York City.
Pangborn Corporation, Hagerstown, Md.

TALC.
International Pulp Co., New York City.
Paxson, J. W., Co., Philadelphia, Pa.
Pettinos Bros., New York City.
Stevens, Frederic B., Detroit, Mich.

TANKS (Steel).
Peck Iron & Steel Co., Kalamazoo, Mich.

TANKS (Pickling).
Corcoran, A. J., Inc., New York City.

TEMPLET LUMBER.
Coale, Thomas E., Lumber Co., Philadelphia.
Smith, Fassett & Co., N. Tonawanda, N. Y.

TESTING APPARATUS.
Keep, W. J., Detroit, Mich.

TIN (Galvanized).
Malleable Iron Fittings Co., Branford, Conn.

TITANIUM.
Goldschmidt Thermit Co., New York City.
Titanium Alloy Mfg. Co., Niagara Falls, N. Y.

TONGS (Crucible).
Paxson, J. W., Co., Philadelphia, Pa.
Whiting Fdy. Equipment Co., Harvey, Ill.

TONGS (Shake Out).
Diamond Clamp & Flask Co., Richmond, Ind.

TOOLS.
Co-operative Engineering Co., Inc., New York.

TOOL GRINDERS.
Tabor Mfg. Co., Philadelphia, Pa.

TOOLS (Electric Portable).
Stow Mfg. Co., The, Binghamton, N. Y.

TOOLS (Molders).
Dobson, William, Canastota, N. Y.

TOOLS (Pneumatic).
Chicago Pneumatic Tool Co., Chicago, Ill.
Cleveland Pneumatic Tool Co., Cleveland, O.
Dayton Pneumatic Tool Co., Dayton, O.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York, N. Y.
Keller Pneumatic Tool Co., Grand Haven, Mich.
Oldham, Geo., & Son, Co., Frankford, Philadelphia, Pa.
Pittsburgh Pneumatic Co., Canton, O.

TOOLS (Special).
Co-operative Engineering Co., Inc., New York.
Keller Pneumatic Tool Co., Grand Haven, Mich.

TORCHES—BLOW (Oxy-Acetylene for Soldering, Brazing, Welding and Cutting).
Davis-Bournonville Co., Jersey City, N. J.
Linde Air Products Co., Chicago, Ill.
Milburn, The Alexander, Co., Baltimore, Md.
Oxweld Acetylene Co., Chicago, Ill.
Prest-O-Lite Company, Inc., Indianapolis, Ind.

TRACK (Narrow Gage).
Hunt, C. W., Co., Inc., West New Brighton, N. Y.

TRACKING (Overhead).
Scully-Jones & Co., Chicago, Ill.
Randall Tramrail Co., Philadelphia, Pa.

TRAMRAIL SYSTEMS.
Brown Hoisting Machy. Co., The, Cleveland.
Coburn Trolley & Track Mfg. Co., Holyoke, Mass.
Northern Engineering Works, Detroit, Mich.
Paxson, J. W., Co., Philadelphia, Pa.
Randall Tramrail Co., Philadelphia, Pa.
Whiting Fdy. Equipment Co., Harvey, Ill.
Yale & Towne Mfg. Co., New York City.

TRANSMISSION EQUIPMENT (Power).
General Electric Co., Schenectady, N. Y.

TROLLEYS.
Brown Hoisting Machy. Co., The, Cleveland.
Chisholm-Moore Mfg. Co., Cleveland.
Coburn Trolley & Track Mfg. Co., Holyoke, Mass.
Curtis Pneumatic Machy. Co., St. Louis, Mo.
Niles-Bement-Pond Co., New York City.
Northern Engineering Works, Detroit, Mich.
Q. M. S., The, Company, Chicago, Ill.
Randall Tramrail Co., Philadelphia.
Whiting Fdy. Equipment Co., Harvey, Ill.

TRUCKS.
Abell-Howe Co., Chicago, Ill.
Biehl Iron Works, The, Inc., Reading, Pa.
Northern Engineering Works, Detroit, Mich.
Sterling Wheelbarrow Co., Milwaukee, Wis.
Whiting Foundry Equipment Co., Harvey, Ill.

TRUSSES (Steel).
Peck Iron & Steel Co., Kalamazoo, Mich.
Brodin Pattern & Supply Co., Chicago, Ill.

TUMBLING BARRELS.
Central Foundry Supply Co., Columbus, O.
Cleveland Nickel Works, Cleveland, O.
Foundry Equipment Co., Cleveland.
General Platers' Supply Co., New York, N. Y.
Hoevel Mfg. Corporation, New York City.
Mott Sand-Blast Mfg. Co., Inc., New York.
New Haven Sand Blast Co., New Haven, Conn.
Obermayer, S., Co., Chicago, Ill.
Paxson, J. W., Co., Philadelphia, Pa.
Sly, W. W., Mfg. Co., Cleveland, O.
Wadsworth Core Mach. & Equipment Co., Akron, O.
Whiting Foundry Equipment Co., Harvey, Ill.

TUMBLING BARRELS (Exhaust).
Illinois Mfg. & Supply Co., Quincy, Ill.

TUNGSTEN.
Primos Chemical Co., Primos, Pa.

TURBINES (Steam).
General Electric Co., Schenectady, N. Y.

TURNTABLES.
Sellers, Wm., & Co., Inc., Philadelphia, Pa.
Whiting Foundry Equipment Co., Harvey, Ill.

VALVES (Air Gun).
Powell, Wm., Co., The, Cincinnati, O.

VALVES (Blow Off).
Powell, Wm., Co., The, Cincinnati, O.
Tessmer Mch. & Tool Co., Detroit, Mich.

VALVES (Foot).
Malleable Iron Fittings Co., Branford, Conn.

Wonham, Bates & Goode,
Inc.

Complete Equipment for Foundries

Whiting Cranes, Cupolas, Tumblers, Ladles, Etc.
Wilbraham-Green Blowers
O. & S. Locomotive Cranes and Buckets
Blystone Sand Mixers
Fire Brick Linings
Porter Locomotives
Brown Sand Blast Tumblers and Tables and Core Making Machinery
Clark Blast Meters

17 Battery Place, New York City
141 Milk Street, BOSTON
3 London Wall Bldgs., LONDON, ENGLAND
PARIS, FRANCE

An "all around" Foundry Shovel

Speed in foundry practice necessitates handy tools.

The shovel handle provides the handiest rammer for the expert molder.

MATTHEWS
PATENT
Rammer Shovel
is designed for a rammer as well as a shovel.

Save the valuable time of your molder by providing him with a "Matthews" handy shovel.

Write for prices.

THE PITTSBURGH SHOVEL CO.
Oliver Building
PITTSBURGH, PA.

Patented
March 27th, 1917

Spattering Metal

offers no hazards to the men who wear

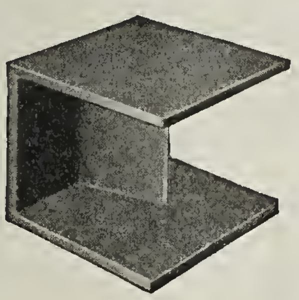
Universal "Safety First" Molders Spring Knee Leggins

They are fire-proof, comfortable and convenient. Can be put on or taken off instantly. Made of leather, asbestos, or fire-proof duck. Especially adapted to workers in iron, steel and brass foundries.

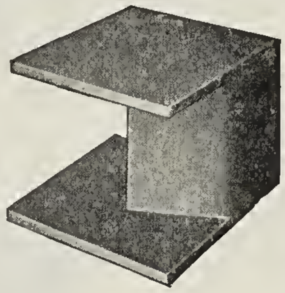
We also manufacture Fire-proof Gloves; Mittens; Aprons; Hip Leggins; Spats; Suits; Coats; Pants; etc.

Write for catalog

The Wheeler & Holcomb Co.
1360 Wells Street **Chicago, Ill.**



To KNIT or not to KNIT?



There is only one answer to-day—it is to KNIT.

Evidences of it are seen on every side.

The results of the knitting mean comfort and satisfaction to the users.

Do you know that the "ANGLE STEM" Chaplet knits and knits everlastingly and will bring satisfaction to you?

That where it enters the casting the section of metal is sound beyond requiring drilling and plugging to make it tight?

That it is in a single piece but with solid, full bearing heads?

That it is made in FIVE gauges of metal, one of which will suit your work?

That its strength is more than equal to any burden you will put on it?

Is there any other double head chaplet as efficient and economical as "ANGLE STEM"? NIT!

Samples and prices for the asking.

COMBINED SUPPLY & EQUIPMENT CO., INC.
766-772 Grant Street **Buffalo, N. Y.**

VALVES (Knee).

Malleable Iron Fittings Co., Branford, Conn.
Tessmer Mch. & Tool Co., Detroit, Mich.

VALVES (Oil Burning Furnace).

Powell, Wm., Co., The, Cincinnati, O.

VANADIUM.

Primos Chemical Co., Primos, Pa.

VENTILATING SYSTEMS.

Hoevel Mfg. Corp., New York City.
Illinois Mfg. & Supply Co., Quincy, Ill.
Ohio Blower Co., The, Cleveland, O.
Pangborn Corporation, Hagerstown, Md.
Sly, W. W., Mfg. Co., Cleveland, O.

VIBRATORS.

Adams Company, The, Dubuque, Ia.
Arcade Mfg. Company, Freeport, Ill.
Berkshire Mfg. Co., Cleveland, O.
Buckeye Products Co., Cincinnati, O.
Malleable Iron Fittings Co., Branford, Conn.
Mumford Molding Machine Co., Chicago, Ill.
Pressed Steel Co., Muskegon, Mich.
Tabor Mfg. Co., Philadelphia, Pa.
Tessmer Mch. & Tool Co., Detroit, Mich.
U. S. Molding Machine Co., Cleveland.
Woodison, E. J., Co., The, Detroit, Mich.

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Magnetic Mfg. Co., Milwaukee, Wis.
Pressed Steel Co., Muskegon, Mich.
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McCormick, J. S., Co., Pittsburgh, Pa.
United Compound Co., Buffalo, N. Y.

WAX (Pattern).

Paxson, J. W., Co., Philadelphia, Pa.
United Compound Co., The, Buffalo, N. Y.

WAX (Vent).

United Compound Co., Buffalo, N. Y.

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Sterling Wheelbarrow Co., Milwaukee, Wis.

WELDING.

Goldschmidt Thermit Co., New York City.

WELDING AND CUTTING EQUIPMENT (Electric Arc).

General Electric Co., The, Schenectady, N. Y.
Lincoln Electric Co., Cleveland, O.
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

WELDING AND CUTTING EQUIPMENT (Oxy-Acetylene).

Cox Brass Mfg. Co., Albany, N. Y.
Davis-Bournonville Co., Jersey City, N. J.
Linde Air Products Co., New York, N. Y.
Milburn, The Alexander, Co., Baltimore, Md.
MacLeod Company, The, Cincinnati, O.
Oxweld Acetylene Co., Chicago, Ill.
Prest-O-Lite Co., Inc., Indianapolis, Ind.

WELDING COMPOUND.

Goldschmidt Thermit Co., New York, N. Y.

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King, Julius, Optical Co., New York City.
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American Clay Machinery Co., Bucyrus, O.
Frost Mfg. Co., The, Chicago, Ill.

WET TOOL GRINDERS.

Blount, J. G., Co., Everett, Mass.

WHEELBARROWS.

Sterling Wheelbarrow Co., Milwaukee, Wis.

WHEELS (Grinding).

Abrasive Co., Bridesburg, Philadelphia, Pa.
Carborundum Company, Niagara Falls, N. Y.
Hampden Corundum Wheel Co., Brightwood, Springfield, Mass.
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Sterling Grinding Wheel Co., Tiffin, O.

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Osborn Mfg. Co., The, Cleveland, O.

WHITE PINE PATTERN LUMBER.

Coale, Thomas E., Lumber Co., Philadelphia.
Smith, Fassett & Co., N. Tonawanda, N. Y.

WINDOWS (Hollow Metal).

Lupton's David, Sons Company, Philadelphia, Pa.

WIRE BRUSHES.

Osborn Mfg. Co., Cleveland, O.
Paxson, J. W., Co., Philadelphia, Pa.

WIRE CLEANING WHEELS.

Osborn Mfg. Co., The, Cleveland, O.

WIRE STRAIGHTENERS.

Shuster, F. B., Company, New Haven, Conn.
Worthington Pump & Mchy. Corp., New York.

ZINC.

American Zinc, Lead & Smelting Co., Boston.
New Jersey Zinc Co., New York City.

ZINC DUST (Sherardizing Zinc).

New Jersey Zinc Co., New York City.

ZINC STRIPS.

New Jersey Zinc Co., New York City.

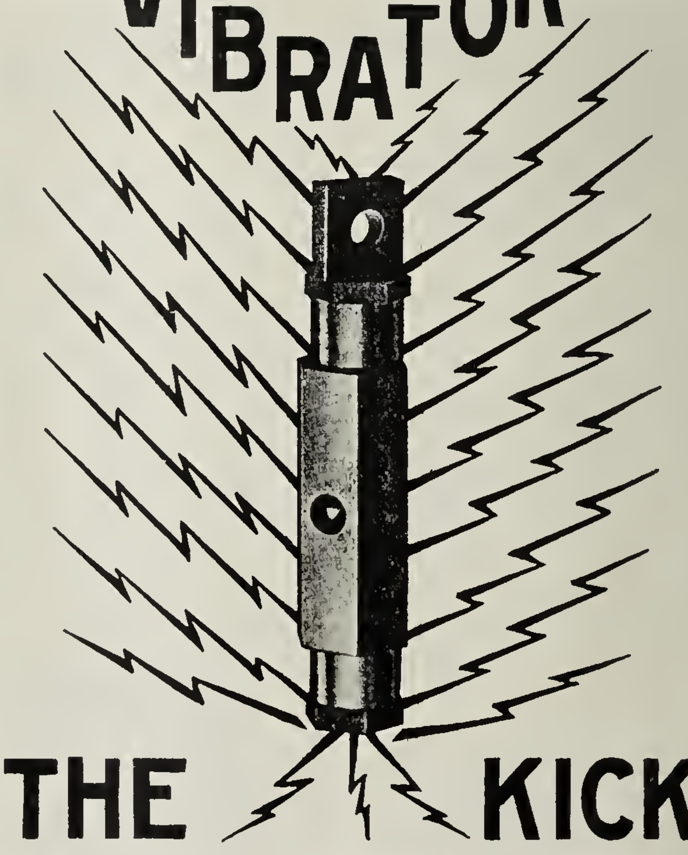
Dixon's Furnace Cement
(C. C. & G.)

Crucible clay and graphite mixture is of a most refractory nature. It is invaluable in patching cracked or worn furnace linings and fire boxes around boilers, lining "Bull" ladles, etc.

Successfully withstands great heat, resists wear and tear and postpones the day of buying new fire brick. Its use will prevent delay and save expensive repairs.

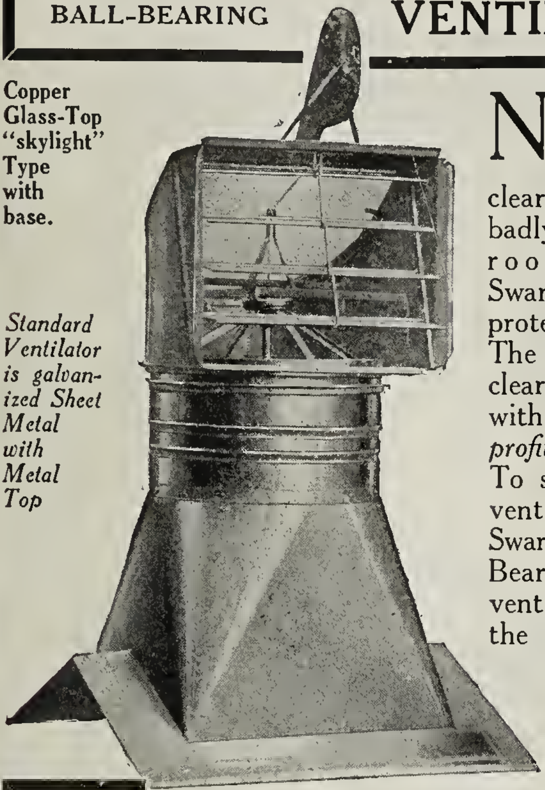
Send for prices and Booklet No. 51-V.

Made in JERSEY CITY, N. J., by the
JOSEPH DIXON CRUCIBLE COMPANY
DIXON ESTABLISHED 1827 DIXON



THE VIBRATOR WITH THE KICK
IS THE "BRANFORD"
Malleable Iron Fittings Company
Branford, Conn., U. S. A.

SWARTWOUT ROTARY BALL-BEARING **VENTILATORS**



Copper Glass-Top "skylight" Type with base.

Standard Ventilator is galvanized Sheet Metal with Metal Top

NO employer can fairly expect clear-headed and clear-eyed workmen in badly aired, dark work rooms. Install Swartwouts for their protection.

The clear heads and clear eyes come and with them *come larger profits.*

To secure *profitable* ventilation use the Swartwout Rotary Ball-Bearing Ventilator, the ventilator that "puts the wind to work." Free wind power creates a vacuum which is filled by a steady flow of used air from within.

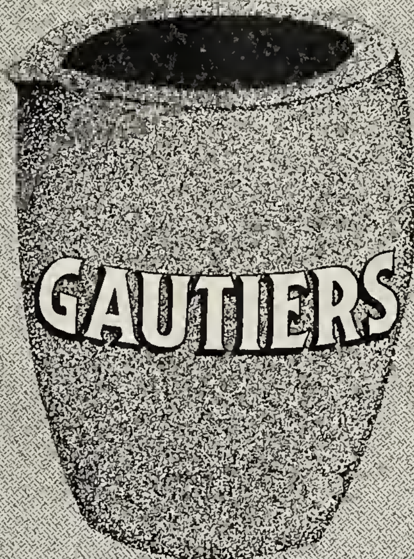
The Swartwout is a *ventilating machine* without operating expense.

The Swartwout Catalog is literally a "Guide to Fresh Air," giving you 24 pages of exact facts, figures, drawings and specifications.

THE OHIO BLOWER CO.
Department "C" Cleveland, Ohio

THE **STANDARD** IN

CRUCIBLES



J.H. Gautier & Co.,
JERSEY CITY, N.J.

Pure Spelter from Pure Ore

For quality mixtures, wherever high-grade spun brass and ornamental bronze are made, use

New Jersey zinc

in Brass

Smelted direct from the exceptionally pure ores of northern New Jersey, this high-grade spelter under the brands of

Horse Head and Bertha

have set the standard of quality for over a generation. They are pure because the ores from which they are produced are pure and are free from cadmium.

We also manufacture Zinc Dust, Spelter, Spiegeleisen, Lithopone, Zinc Sheets and Plates, Zinc Chloride and Sulphuric Acid (all concentrations.)

THE NEW JERSEY ZINC COMPANY
55 Wall Street, New York
ESTABLISHED 1848
Branch: Mineral Point Zinc Company
1111 Marquette Building
Chicago, Illinois

NORTHERN CRANES

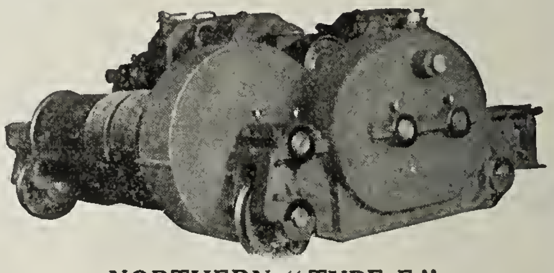
All Types of Traveling and Jib Cranes

¶ Our Type E Electric Traveling Crane has all those features which make it ideal for the modern Foundry.

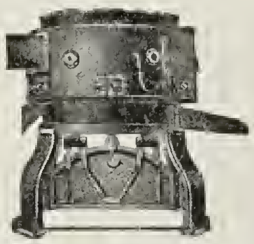
¶ Over seven years ago we designed and patented our Type E Crane Trolley and have persistently advocated its construction since that time.

¶ Perhaps the most sincere tribute paid it is by those competitors who for many years decried its design and who are now frankly attempting to adopt it as their own.

¶ It is patented and infringers will be prosecuted.



NORTHERN "TYPE E"
PATENTED CRANE TROLLEY



NEWTEN CUPOLA

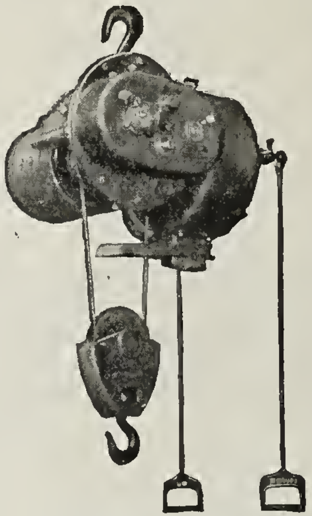
14 SIZES—THE LATEST
MODERN IRON MELTER

Let us show you some crane feature of interest. Better send for our Catalogs.

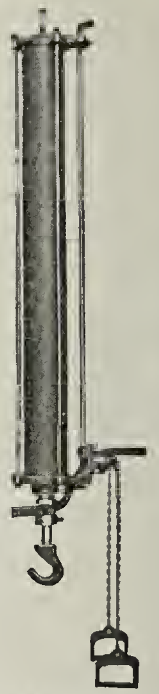
We also make

FOUNDRY LADLES
TROLLEYS and TRACKS
TRUCKS—TUMBLERS
ELECTRIC and AIR HOISTS
THE NEWTEN CUPOLA

Ask us for prices when in the market



NORTHERN "TYPE D"
ELECTRIC HOIST
A Portable Electric Hoist with steel gearing and modern construction.
¼ Ton to 10 Tons—AC or DC



AIR HOISTS
2" to 20" sizes

NORTHERN ENGINEERING WORKS, 4 Chene St., Detroit, Mich., U. S. A.
(or Canadian Works—Northern Crane Works, Ltd., Walkerville, Ontario)

CHESAPEAKE CRANES

5 to 25 Tons Capacity
Direct Current Electric Traveling Cranes
Most Rugged Crane Built
QUICK DELIVERY

CHESAPEAKE IRON WORKS, Baltimore, Md.

NILES CRANES

Built In Any Size Required

Niles Electric Traveling Cranes are designed to obtain the highest operating efficiency with the lowest cost of maintenance. They are of liberal design, allowing an ample factor of safety throughout. Built to operate continuously, all problems of maintenance and repairs have been successfully solved. All parts for units of same size are interchangeable and are readily accessible for examination or removal.

Write For Our Crane Catalog

NILES-BEMENT-POND CO.

GENERAL OFFICES, 111 BROADWAY, NEW YORK

BOSTON PHILADELPHIA PITTSBURGH CINCINNATI CLEVELAND DETROIT CHICAGO ST. LOUIS BIRMINGHAM, ALA. SAN FRANCISCO

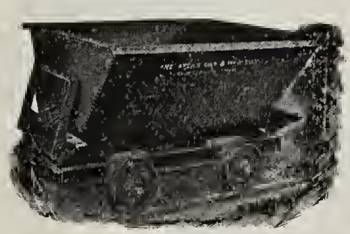
THE SHAW ELECTRIC CRANE COMPANY

WORKS MUSKEGON, MICHIGAN

SALES OFFICES IN ALL PRINCIPAL CITIES

MANNING, MAXWELL AND MOORE, INC.

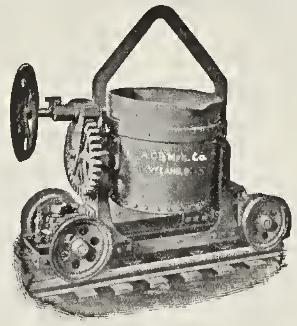
PRINCIPAL OFFICE - 119 WEST 40TH. ST., NEW YORK.



The Atlas Car & Mfg. Co.

CLEVELAND, OHIO

Manufacturers



Small Cars of all kinds for various purposes, Sand Buckets, Turntables, Rails, Frogs, Switches, Etc.

Foundry Equipment a Specialty

Hayward Buckets

For Mixing, Cutting and Conveying Sand

THE Hayward Electric Motor Bucket can help in the foundry in so many ways that even the smaller companies can and do employ it to advantage.

The illustration depicts some of the many possibilities of this self-contained easily controlled bucket in the foundry of an automobile factory where it is used for mixing, cutting and conveying the molding sand. The ability of the bucket to work under low ceilings makes possible its use for conveying the sand to storage bins to the left of the sand piles and in reclaiming it from these bins and dumping it down the chute.

CATALOG 44 Gives the blue-print plans of this and many other successful installations. The Catalog was written for you. Won't you write for it?

The Hayward Company, 50 Church St., New York

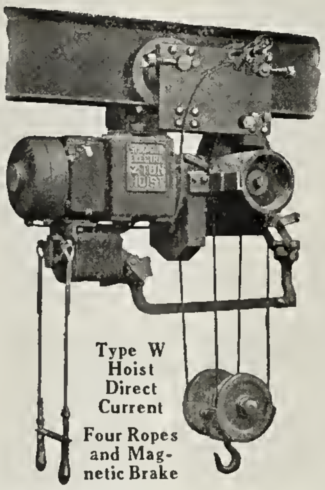
BROSIUS Single Hook Grab Bucket

Can be attached to any crane or hoist in a moment's time without previous preparation; simply throw the hook block of the bucket over the hook of the crane and go to work.

If you have not already replaced hand labor in your foundry with a Brosius Single Hook Grab Bucket, you will soon **have** to do so. One bucket will take the place of 25 men that Uncle Sam needs. How about it?

Over 65 foundries are now using them — over 280 in daily use.

EDGAR E. BROSIUS
PITTSBURGH, PA.



Type W Hoist Direct Current

Four Ropes and Magnetic Brake

Sprague Electric HOISTS ONE TO SIX TONS

Used outdoors and in Foundries, Machine Shops, Pressrooms and Warehouses.

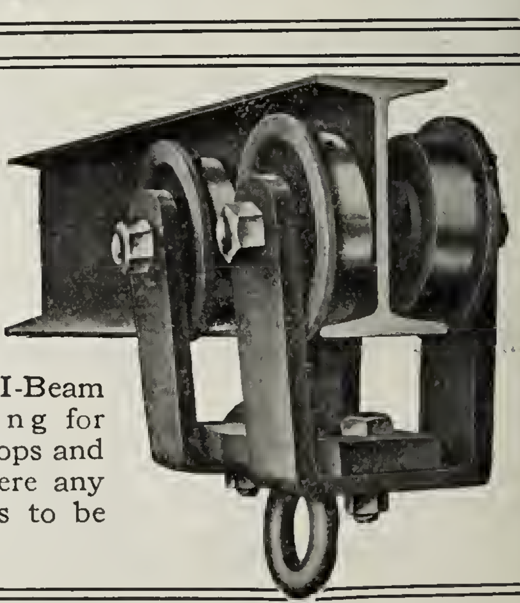
SAFE—DURABLE—FOOL PROOF

Send for Bulletin No. 48923

Sprague Electric Works
of General Electric Company
Main Offices: 527-531 W. 34th Street
New York
Branch Offices in Principal Cities

RANDALL TRAMRAIL COMPANY

Philadelphia, Pa.



Overhead I-Beam and Tracking for Foundries, Shops and all places where any conveying has to be done.

Put a
Mathews
Roller Conveyer
under your pigs.

Rolling by gravity is cheaper, quicker and easier than carrying by means of expensive man power.

Made in six foot portable units, ball bearing steel rollers. Entire construction is designed to give great strength without excessive weight.

Useful for handling a great variety of heavy commodities, such as billets, shell forgings, castings, bars, angles, etc.

Write for Bulletin 13

**Mathews
Gravity Carrier
Company**
Ellwood City, Pa.
BRANCH FACTORIES:
Toronto, Ont. London, Eng.

TRADE **YALE** MARK

Triplex Block setting steel bars.

Yale Hoists—the friend of Labor

No better method for increasing the productive efficiency of highly paid labor can be found than the use of the Yale Triplex Block to facilitate the rapid, safe and economical handling of loads.

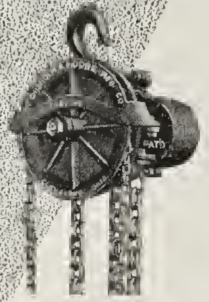
The Yale Triplex Block also increases output by cutting down non-productive time of machines. Rough material is quickly set and finished product safely and expeditiously removed.

The Yale Triplex Block is adaptable to every industry where the efficient handling of loads is a factor. Made in capacities ¼ ton to 40 tons—each block is tested to 3360 pounds for each rated ton.

For Sale by Machinery Supply Houses
PUT YOUR HOISTING PROBLEMS UP TO US
ASK FOR NEW CATALOG
For factory locking equipment use a Yale Master-key System.
Write us for particulars.

The Yale & Towne Mfg. Co. 9 East 40th Street
New York City

CYCLONE HIGH SPEED HOISTS
Safety—



The construction is very sturdy—all hoists being made sufficiently strong to pass an overload test of 50 per cent.

*Hoisting Handbook No. 55
is sent free on request.*

The Chisholm-Moore Mfg. Co
Cleveland, O.

TOLEDO CRANES
DETAILS ARE CONVINCING
Let Us Show You
CRANES and HOISTS FOR EVERY SERVICE
THE TOLEDO BRIDGE & CRANE CO.
Toledo, Ohio

TIP CARS *for coke or sand*

It makes the work easy—also saves a great amount of time and money. Write us at once.

C. W. HUNT CO., Inc.
West New Brighton, N. Y., U. S. A.
61 Broadway, N. Y. City Fisher Building, Chicago
710 14th St., N. W., Washington
Send for Catalog D-16-2.

CONNERSVILLE
BLOWERS

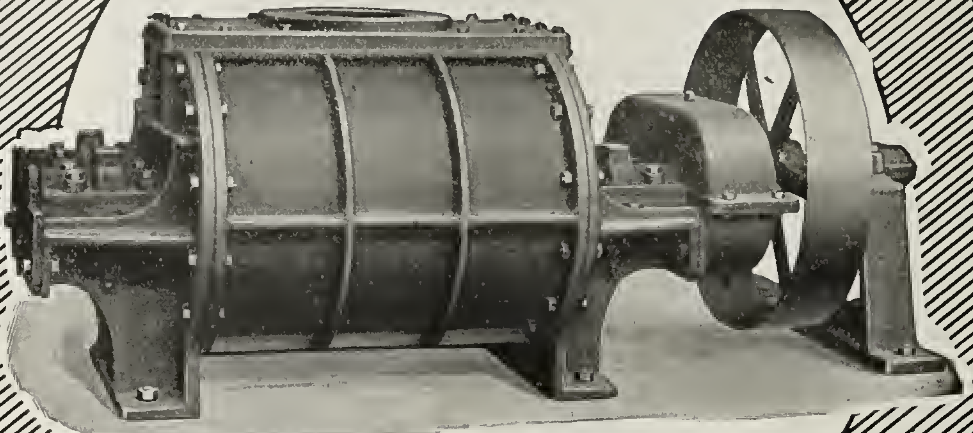
Exact—economical—durable

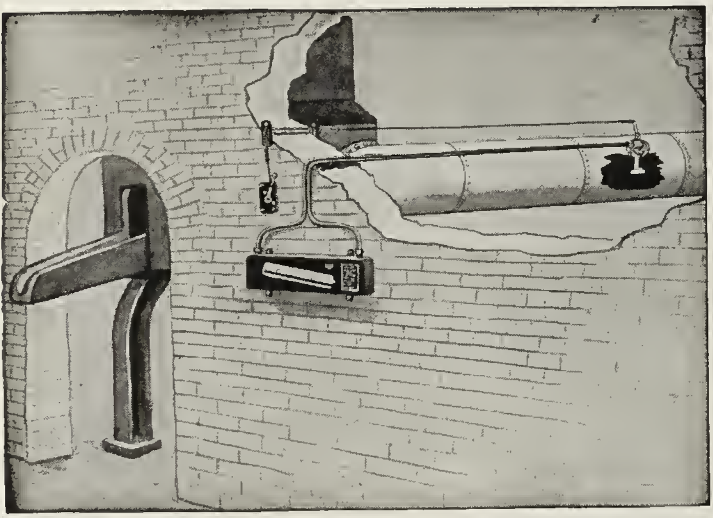
Built for any pressure between ½ and 10 pounds, and in any capacity.

Most practical and efficient for foundry or steel converter use.

Write for catalog.

The Connersville Blower Co.
Connersville, Indiana
New York: 114 Liberty St.
Chicago:
929 Monadnock Bldg.





"We Are Saving 500 lbs. of Iron

per day, and the results in other respects are beyond our expectations," writes a foundryman after using the Clark Blast Volume Meter a month.

Not an unusual instance at all,—400 other foundries average as well or better. No other piece of foundry equipment pays a bigger return on the investment than the Meter.

If you haven't seen our new C-4 bulletin, write for a copy—it is full of practical information.

CHAS. J. CLARK
1716 W. Adams Street
CHICAGO, ILL.

CLARAGE
KALAMAZOO
EXHAUST FANS

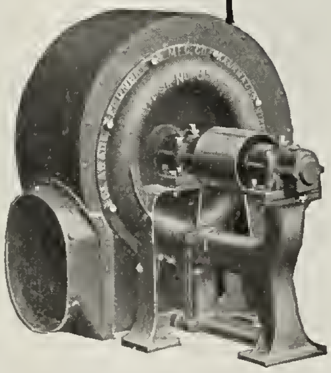
PROMPT SHIPMENT

That is the deciding factor these days when you are directing every effort and employing every available means to take care of "war business."

If you are in need of a Fan or Blower, you will undoubtedly want it as soon as possible, and quality being equal, you're going to buy where you can be assured of the best delivery.

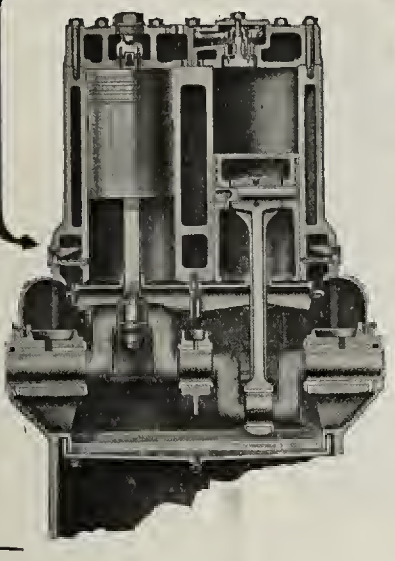
And that's just the point we pride ourselves upon—Prompt Shipment. Immediate shipment is possible upon our Exhaust Fans because they are carried in stock.

If your Fan is for Government work, we'll hustle it along in no time.



Clarage Steel Plate Exhausters
Single or Double Fans built in sizes 25" to 120".

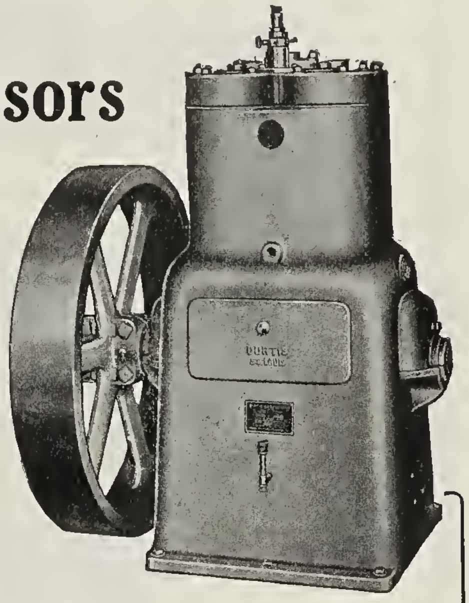
CLARAGE FAN COMPANY.
HEATING, VENTILATING & DRYING ENGINEERS.
KALAMAZOO—MICHIGAN—U. S. A.



NOTE THE LUBRICATION AND COOLING SYSTEMS

Every moving part amply and automatically lubricated with no excess oil carried over into the air line—no waste

Curtis Air Compressors



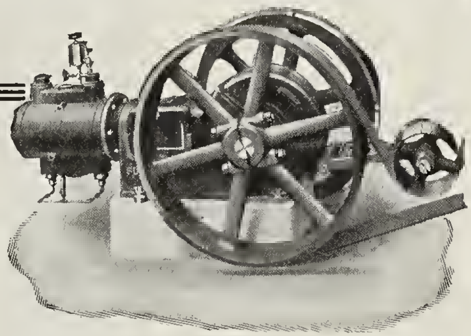
Have splash lubrication and will run for weeks on one oiling up, with less attention than your line shaft—but unlike other splash oiling systems, the oil is not splashed directly into the cylinders and the amount of oil furnished pistons and wrists can be regulated—by an adjustable sight feed device.

COOLING—They have more than the usual amount of water-cooled area—heads and valve pockets, as well as cylinder walls, are water jacketed. This means higher efficiency than usual.

VALVES—the heart of the compressor, in the Curtis are stemless vanadium steel discs, that mean higher efficiency than the poppet type of valve so commonly used, are more silent in operation, simplify the air end, increase dependability and efficiency at high speeds and permit continuous operation under severe conditions. The Curtis valves can be removed without removing heads.

Write for our New Compressor Catalog

Curtis Pneumatic Machy. Co., 1545 Kienlen Ave., St. Louis, Mo.
New York Office: 30 Church Street



—there's a

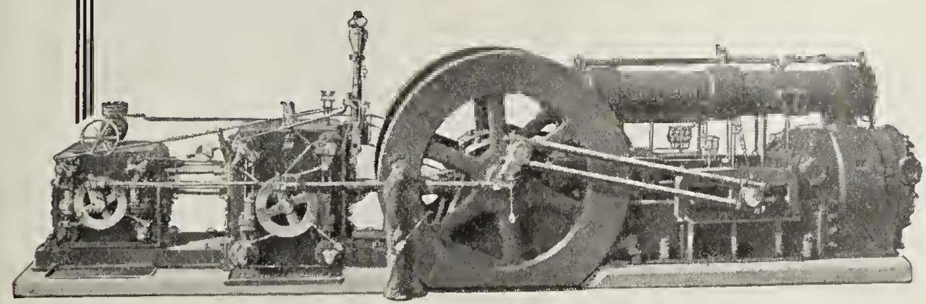
Sullivan Air Compressor

just right as to size, drive and type to render efficient, dependable air power service for your Foundry.

These two pictures show the range of Sullivan Compressor manufacture—above a 6x6, belted splash-oiled, "WG3"—below, a "WC" tandem-compound Corliss steam, two-stage air machine, 3150-ft. capacity.

If you need a new air compressor this winter, get posted on the details of Sullivan Compressor Excellence.

A set of 5 Sullivan Compressor bulletins will be sent (free) to anyone mentioning this announcement.



Sullivan Machinery Co.
122 So Michigan Ave., Chicago, Ill., U.S A.

OLDHAM HAMMERS

Greater working capacity.

Less consumption of air.

Efficient, economical, durable.

Suitable for any foundry use.

Oldham Pneumatic Tools are *dependable tools.* Built for strength, durability and efficient service.

Chipping Hammers
Foundry Rammers
Core Busters

Any tool sent on approval.

Write for catalog.

GEORGE OLDHAM & SON CO.
Frankford, Philadelphia, Pa.

Use

Grinding Wheels

and

eliminate your grinding difficulties

In Sterling Wheels you have the ideal combination for a fast and cool cutting wheel.

Made of artificial abrasives, there is no work that they cannot grind economically.

Their superior cutting qualities permit of greater output at a saving of time and power.

Made in all shapes and sizes to fit any machine.

The Sterling Grinding Wheel Co.
Tiffin, Ohio, U. S. A.

Chicago
30-32 N. Clinton St.

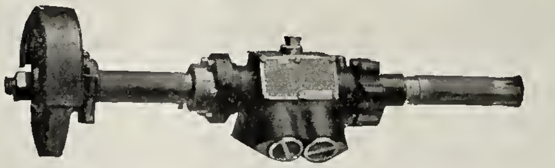
L. Best Co.
75 Barclay St.
New York, N. Y.

Cleveland AIR TOOLS

PORTABLE EMERY GRINDER

STYLES A and AA

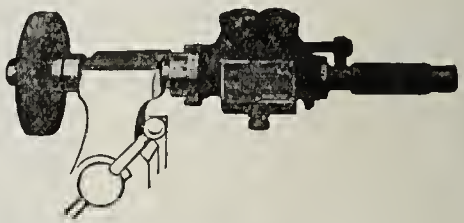
3000 REVOLUTIONS PER MINUTE



Will drive 6-inch and 8-inch wheels with 1 1-4-inch face.

The Throttle Handle and Forward Handle are in alignment, balancing machine on center, insuring perfect control and permitting operator to regulate speed or shut off air power without removing his hand from throttle. Adapted to Grinding Castings, Polishing, Buffing, etc. Fitted with wheel guard if required.

Locked in a vise it becomes a permanent grinder for edging Small Tools.



If you are interested we will ship sample grinder for trial at our expense

Write for Illustrated Bulletin No. 35

The Cleveland Pneumatic Tool Co.

General Offices and Works
CLEVELAND, OHIO

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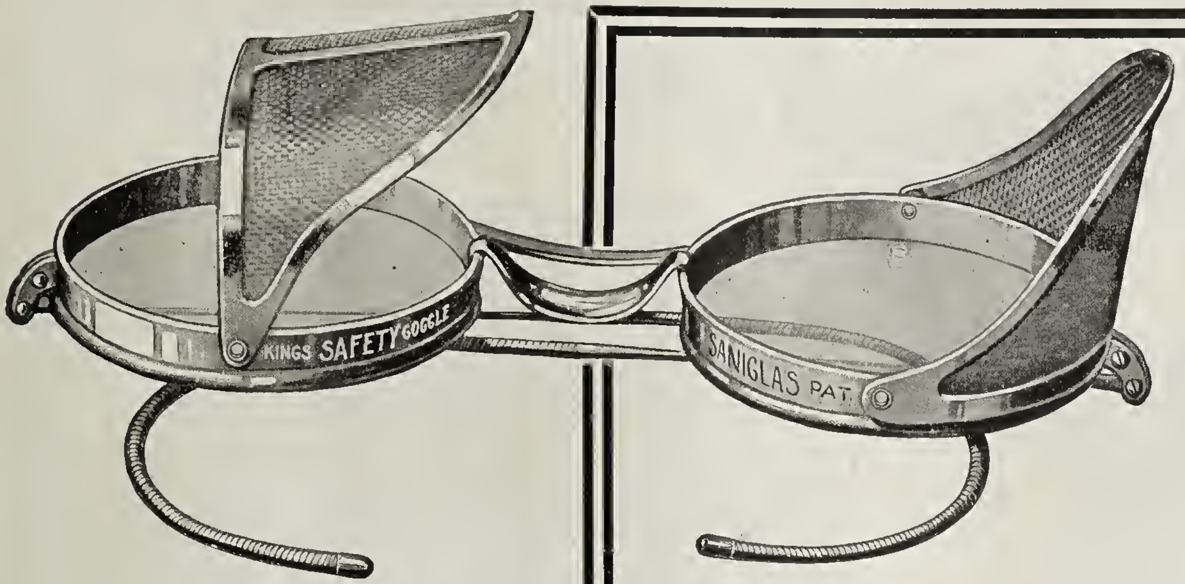
Pittsburgh
Detroit
Chicago
Toronto
Philadelphia
San Francisco

John MacDonald & Company, Pollokshaws, Glasgow, Scotland



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are the eyes of your workmen. Hundreds of workmen lose the sight of one or both eyes every year, through flying chips; but *thousands* of men *save* the sight of their eyes every year by wearing *King's Safety Goggles.*

King's Safety Goggles are the standard for the big industries because they have saved them thousands of dollars.

Cheap goggles are more dangerous than no goggles at all.

Then don't fail to specify the standard goggles—*King's* Safety Goggles!

May we send you our booklet "Let Us Save Your Workmen's Eyes"? ***Write us.***

Julius King Optical Co.

10-12 Maiden Lane
NEW YORK

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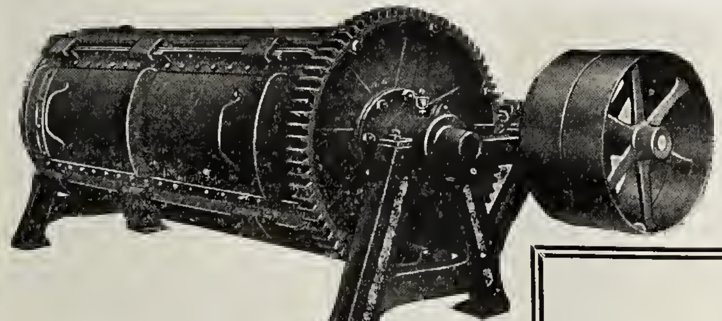


Crucible Shanks and Tongs; Brass Melting Furnaces; Elevators, etc. Also repair parts for Byram & Co. Foundry Equipment.

Tumbling Mills; Turntables; Foundry Cars; Hand Power Jib and Traveling Cranes; Core Ovens; Core Oven Cars.

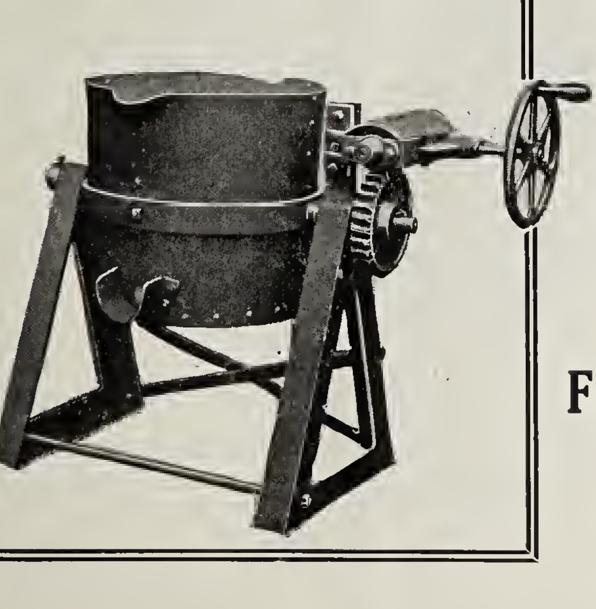
We manufacture the *Improved "Byram" Ladles* as well as the complete line of Foundry Equipment formerly manufactured by Byram & Co., including the *Standard Colliau Cupola.*

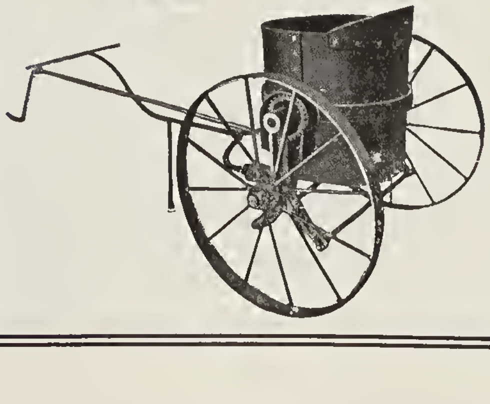
Send us your next order.

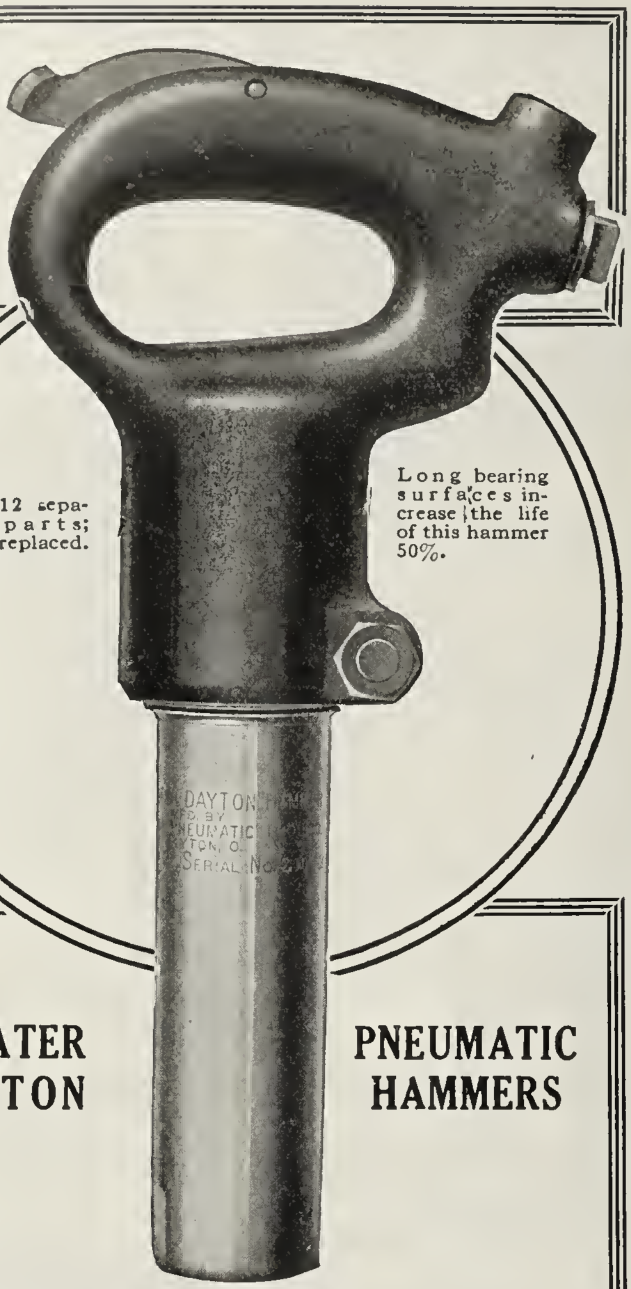
The Central Foundry Supply Co.

Foundry Equipment and Supplies

COLUMBUS, OHIO







Only 12 separate parts; easily replaced.

Long bearing surfaces increase the life of this hammer 50%.

GREATER DAYTON PNEUMATIC HAMMERS

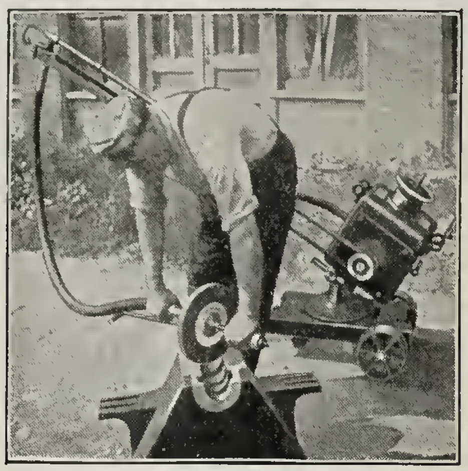
Greater Dayton Hammers have to please, before we consider them sold.

We will send you any of the various sizes, on trial, prepaid, with the distinct understanding that if you do not find them more satisfactory, economical and efficient than any other hammer you have ever used, you can return them at our expense.

Order at once; 90% of our shipments are made the same day order is received.

The Dayton Pneumatic Tool Co.
P. O. Box 1116, DAYTON, OHIO

***Stow* Portable Grinder**
Adjustable



Motor Driven
Built in All Sizes, All Currents

Saves Time

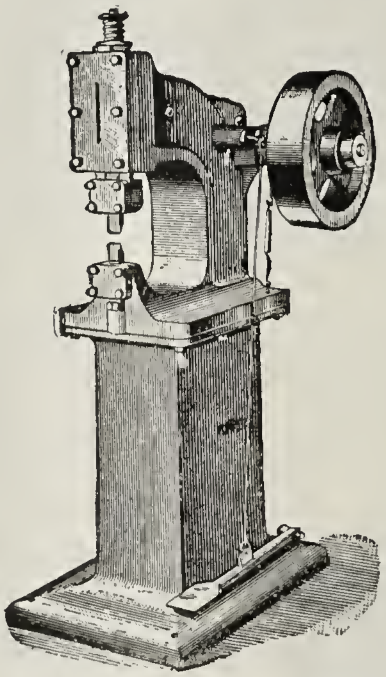
Cuts Cost

Maximum efficiency in grinding. Adaptable to drilling.

Stow tools are an investment and not an expense.

Stow Manufacturing Company
Binghamton N. Y., U. S. A.
Inventors and manufacturers of Stow Flexible Shaft

POWER SPRUE CUTTERS for BRASS FOUNDRIES



Strong Machines, made in several sizes, ample throat room for bulky pieces. Cut fast and clean.

Save their cost in a short time.

The F. B. Shuster Co.
New Haven, Conn.

Formerly John Adt & Son Established 1866
Also makers of Straighteners and Cutters for cutting up core wires.

“CARBISIL” WHEELS made of Carbide of Silicon

For Cast, Chilled and Hard Iron —Brass, Bronze and Aluminum

Here are some grades that have run away with big orders—and the orders are from firms who have considered *every* element in grinding cost:

KIND OF WORK	GRIT	GRADE
Heavy Grey Iron Castings	16	S
Medium “ “ “	20	S
Light “ “ “	24	S
Chilled Iron - - -	20	T
Hard Iron - - -	14	T
Brass Castings - -	24	Q
Bronze - - - -	20	Q
Aluminum - - -	20	Q Special

Hampden Corundum Wheel Co., Springfield, Mass.

“Grinding Wheel Makers for over a Quarter of a Century”

Thor

Pistol Grip Foundry Chipping Hammer at Work on Casting Also Showing the *Thor* Quick Hose Coupling.

Chipping Hammers with Single Valve of Latest Design No Vibration

Light and Easy to Handle Fast Powerful and Durable

IMMEDIATE DELIVERY

Independent Pneumatic Tool Company

Chicago, New York, Pittsburgh, Detroit, Birmingham, San Francisco, Montreal

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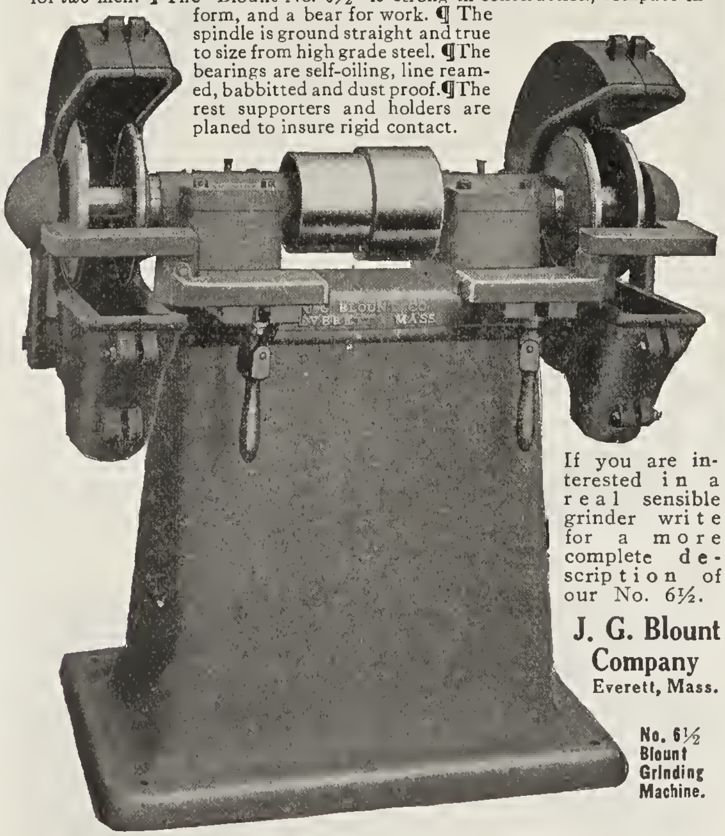
Extra Heavy Construction, Self-Oiling Dust Proof Bearings

Here’s a Sensible Grinder for Foundry Needs

Our No. 6½ Grinder illustrated here, can be used for all kinds of heavy grinding, and is especially adapted to foundry work. ¶ Where floor space is at a premium, this BLOUNT GRINDER is an economizer. ¶ It occupies the floor space of but *one ordinary* grinder, and provides working facilities for *two* men. ¶ The “Blount No. 6½” is strong in construction, compact in form, and a bear for work. ¶ The spindle is ground straight and true to size from high grade steel. ¶ The bearings are self-oiling, line reamed, babbitted and dust proof. ¶ The rest supporters and holders are planed to insure rigid contact.



If you are interested in a real sensible grinder write for a more complete description of our No. 6½.

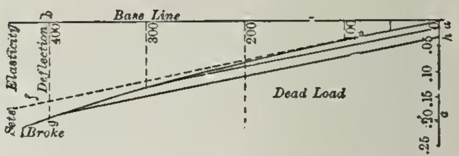
J. G. Blount Company
Everett, Mass.

No. 6½ Blount Grinding Machine.

MECHANICAL ANALYSIS

No. 10
DEAD LOAD
TESTING
MACHINE

PATTERNS AND FOLLOW BOARD



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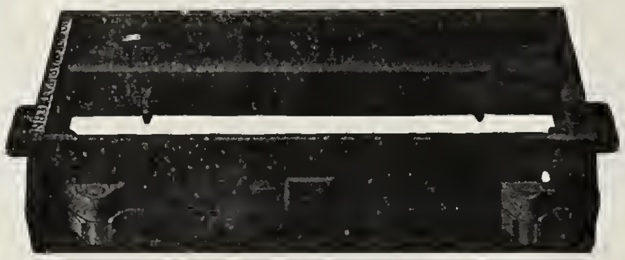
In Use 15 Years

Worcester, Mass.

Has been a great aid to us in securing good mixtures in our Foundry. It has been entirely satisfactory.

HOLYOKE MACHINE CO.
By Charles R. Holman.



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The Injector Sand Blast
For Cleaning All Castings
Made by J. M. BETTON
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Write for "Sandcraft"

Electric Traveling Cranes
Second-Hand Foundry Equipment
Bought and Sold.
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GAUGES
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The Production of Malleable Castings
By RICHARD MOLDENKE

A practical treatise on the processes involved in the manufacture of Malleable Cast Iron

The First and Only Book of
Its Kind Ever Published

CONTENTS OF CHAPTERS

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The Testing of Malleable Cast Iron
The Pattern Shop.
Molding Methods in the Malleable Foundry
Melting Processes.
The Construction and Operation of the Air Furnace.
Construction and Operation of the Open-Hearth Furnace.
The Use of Gas Producers in Malleable Foundries.
Mixing the Charges for Malleable Iron.
Casting Malleable Iron.
Annealing Malleable Castings.
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Use of Pyrometer in Annealing Room.
Cost of Malleable Castings.
Index.

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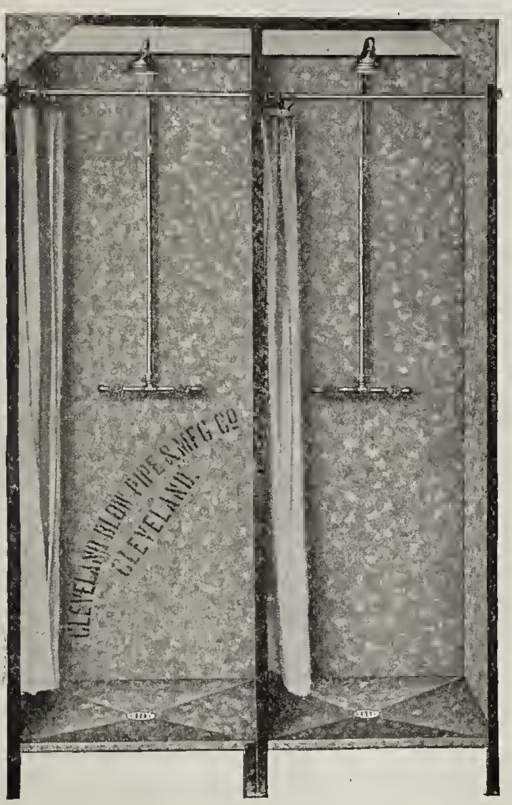
Printed in large, clear type and handsomely bound in cloth in two colors. 150 pages, 35 excellent illustrations.

Penton's Book News
CLEVELAND, OHIO
405

Sheet Metal Shower Baths



These shower baths, specially designed for foundries, are so complete that they more than meet all state law requirements.

Notice the unusual leg attachment which serves the double purpose, first, of raising the baths six inches from the floor, eliminating the settling of water around the sheet metal bottoms; and second, of giving the plumber plenty of working space. These baths are thoroughly approved by all factory inspectors. *Write us now about your requirements.*

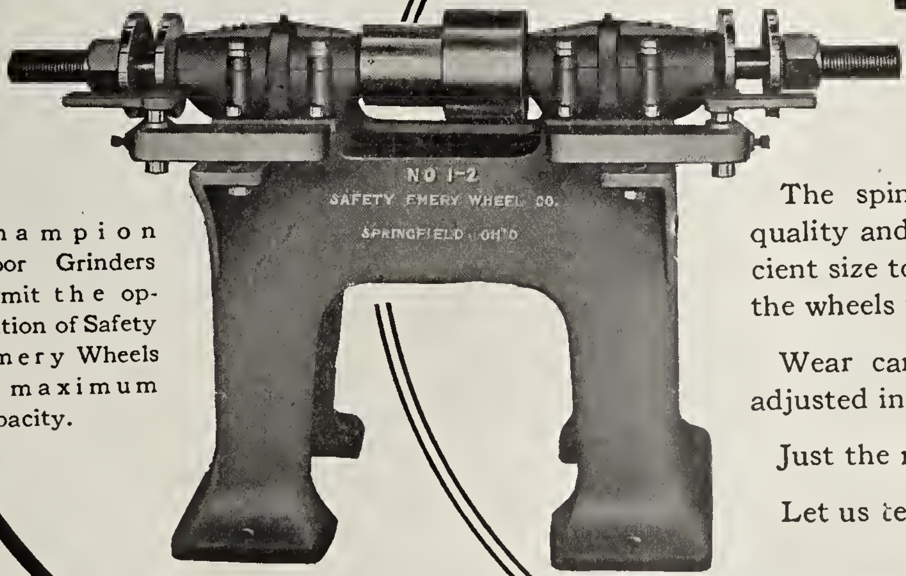
We also build highly efficient Dust Collecting Systems for all industrial purposes.

VACUUM HOODS for use on Buffing, Polishing, Emery and Grinding Wheels, etc.

CLEVELAND BLOW PIPE & MFG. CO.
6302 Kinsman Road **CLEVELAND, OHIO**

Built for stability as well as efficient service.

CHAMPION SAFETY TRADEMARK FLOOR GRINDER



A strong and durable machine, built especially for foundry use.

Champion Floor Grinders permit the operation of Safety Emery Wheels at maximum capacity.

The spindle is of extra size and quality and the pulleys are of sufficient size to furnish ample power for the wheels used.

Wear can be quickly and easily adjusted in every direction.

Just the machine for your work.

Let us tell you more about it.

Send for our literature on Safety Collars.

The Safety Emery Wheel Co.
SPRINGFIELD, OHIO

A little bit goes a long way and makes no dust

The Scientific Metallic Sand Blast Abrasive

ANGULAR

TRADE MARK
Reg. U. S. Pat. Office

GRIT

One Ton of *Angular Grit* will clean as many castings, forgings, etc. as will from two to four *car loads* of sand. It also cleans quicker and better than either sand or shot.

The use of Angular Grit in your sand blasts does away with the necessity of having large storage bins and sand dryers.

It also reduces handling costs to the minimum.

Angular Grit can be used over and over again—it does not crumble or break down into dust—it has to be worn away.

Let us send you samples.

Pittsburgh Crushed Steel Co.
(Sole Mfrs.)
PITTSBURGH, PA., U. S. A.
Established 1888

WHERE
Shall We Send It?

Every Tool Room Man should have this booklet.

There are 40 pages full of good information on tool room grinding—cutters, reamers, drills, taps and dies, lathe and planer tools.

It's yours for the asking. Just send us your address and a copy of this valuable little booklet will be mailed FREE of charge without any obligation to you.

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WORCESTER, MASS.

USE COUPON, LETTER, OR POSTCARD—ASK FOR BOOKLET 835-H

NORTON COMPANY, **Worcester, Mass.**

Please mail my copy of Booklet 835-H to the following address:

Name ....

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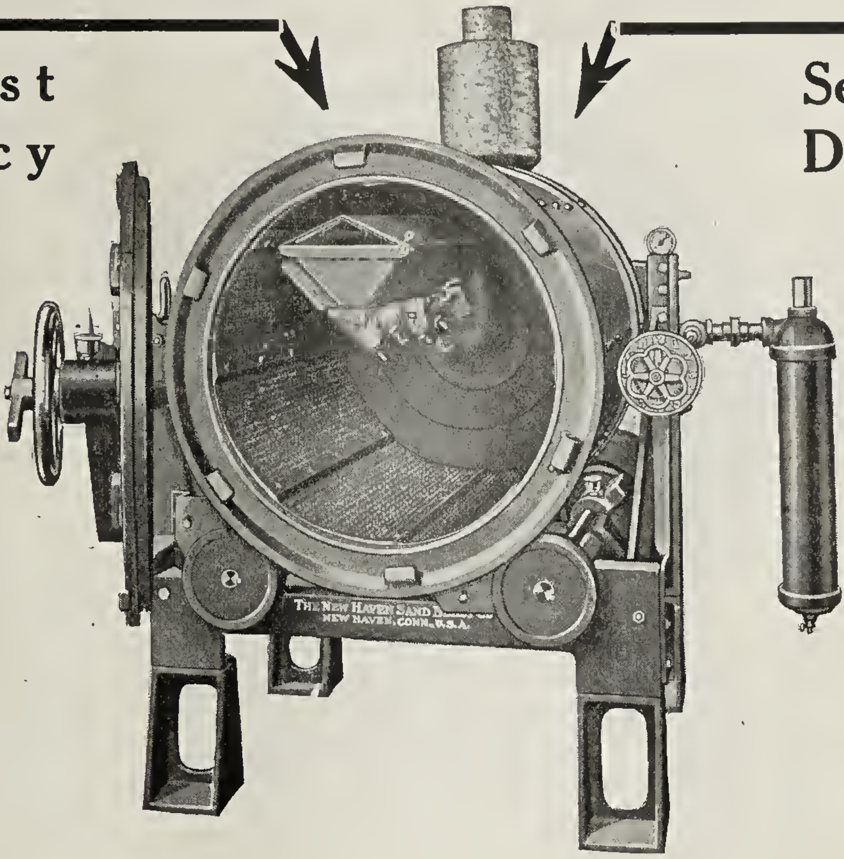
Sandblast Efficiency

The New Haven Sand Blast Barrel is the only genuine self-contained sand blast barrel where the cleaning material does not leave the inside, but is used over and over on the work.

The accumulation of dust and dirt from the castings is confined inside of the machine and removed by direct exhaust from the barrel. There are many other features connected with the New Haven Barrel which we would like to tell you about. Let us send you our catalog.



Self-Contained Dustless

When this machine is first placed in operation, the sand valve is adjusted until the proper amount of sand is entering the mixing chamber. Then it is allowed to remain in that position. The sand stops and flows automatically. The moment the air is turned on the machine is in full operation.

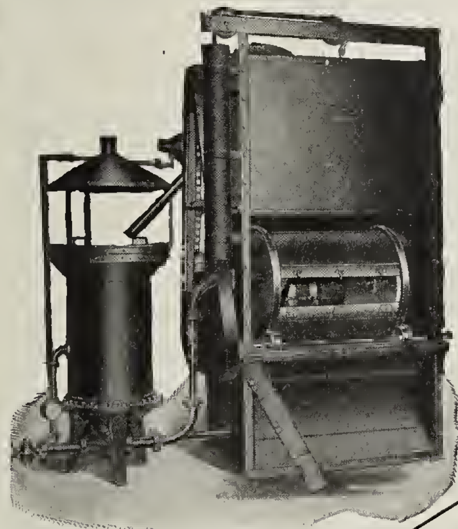
The "New Haven" will help you immensely in saving time and money.

We are exclusive agents for DIAMOND GRIT.

New Haven Sand Blast Co.

New Haven, Conn.

Revolving Barrel Machine



Barrel revolves slowly thereby turning pieces over. Cleaning done by sandblast only, not by tumbling.

Consider Operator and Output

Pressure System Insures Economy and Efficiency

Efficient and Economic

DUSTLESS, SELF CONTAINED, AUTOMATIC SANDBLAST

Every Kind of Sandblast Equipment

Dustless Sandblast Rooms

U. S. Patent 821776

Rotary Table Machine

U. S. Patent 777201

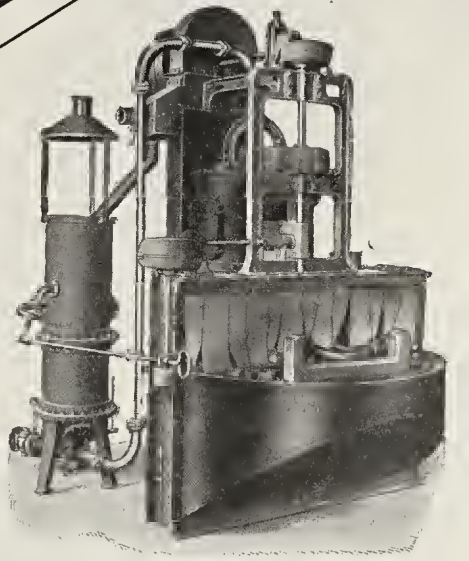


Table rotates continuously at slow speed. Even distribution of sandblast all over the surface of the table by rotating nozzles.

DUSTLESS SELF-CONTAINED
HOEVEL SANDBLAST
AUTOMATIC
MACHINES

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Hoevel Manufacturing Corporation

46 Church Street
NEW YORK, N. Y.

CLEVELAND OFFICE:
410 AMERICAN TRUST BLDG.

25 Years' Experience

New
Imported
Model

$5.00

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The Pulmosan
Sand Blast Helmet

Built right—fits anybody.

Completely protects the eyes, ears and lungs of the wearer.

Insures proper vision and circulation.

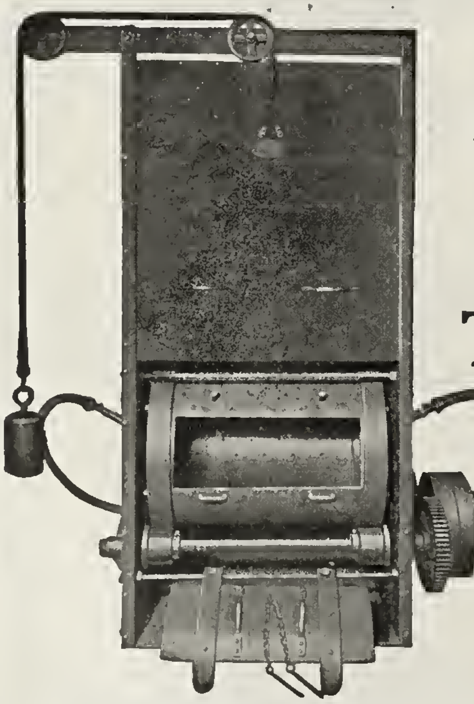
Is thoroughly comfortable.

The Pulmosan Sand Blast Helmet consists of three parts easily separable, any of which can be replaced at nominal cost.

It is strongly recommended by superintendents, purchasing agents, foundry owners etc. who have come in contact with it.

Send us a trial order.

MULTI-METAL SEPARATING SCREEN CO.
249 West 19th Street New York, N. Y.



Your
Attention
One
Moment

Tilghman
Sand
Blast
Tumbling
Barrel

We just wish to remind you that the proper equipment for your sand blast room is Tilghman Sand Blast Equipment.

Write for our catalog of Air Compressors, Sand Blast Machines, Goggles, Respirators, Helmets, etc.

Tilghman-Brooksbank Sandblast Co.
1126 South 11th St., Philadelphia, Pa.
Detroit, Kerr Bldg.

QUICKEST GLOBE CLEANEST

Use grains of IRON instead of grains of sand
BY BLASTING WITH

GLOBE CHILLED SHOT

Globe Chilled Shot can be used from 150 to 200 times. One ton will greatly outservice from *twenty to thirty* tons of the best sand blast sand. It eliminates dust and conserves storage space.

We are anxious to send you samples and prices.

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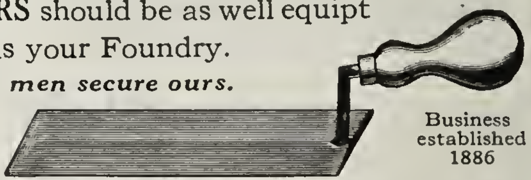
Your MOLDERS should be as well equipt with TOOLS as your Foundry.
Help your men secure ours.

"Perfect in shape, hang, temper, finish."



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1886

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CANASTOTA, N. Y.

GREENE ARC FURNACES
FOR MELTING IRON AND STEEL
QUICK DELIVERY
SEND FOR "ELECTRIC FURNACE INFORMATION"
ALBERT E. GREENE, Representative
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CAPE MAY CITY, N.J.

Experimenting
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EXPENSIVE
PASTIME

You haven't the time to waste now.

Use *sand* with a *known* efficiency.

Use sand
- —that has stood the sand-blast test
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Hundreds of successful foundrymen are using it and won't use any other.

Let us send you samples of our different grades—it will cost you nothing.

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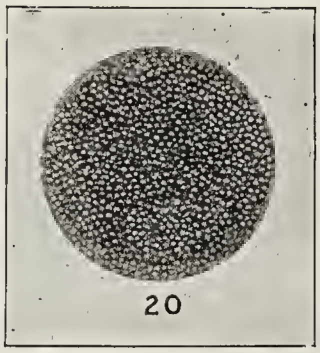
CAPE MAY CITY, N.J.

Work faster Last longer

HARRISON'S CHILLED SHOT AND DIAMOND GRIT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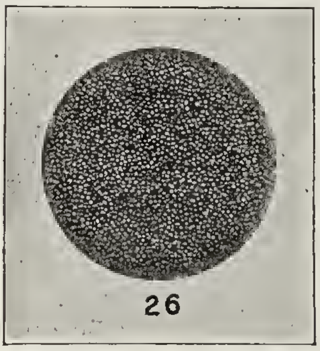
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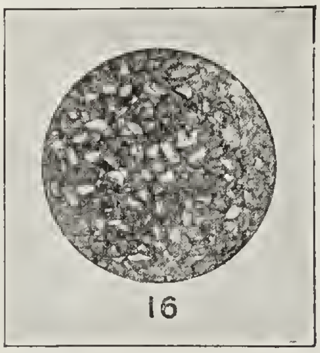
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One ton of either Shot or Diamond Grit would do as much work as several carloads of sand.

They save time—increase production—require but small storage room.

Diamond Grit or Shot eliminates dust from the very fact that these abrasives cannot be broken, but must gradually wear away.

Prompt shipments —any size.

Samples free.

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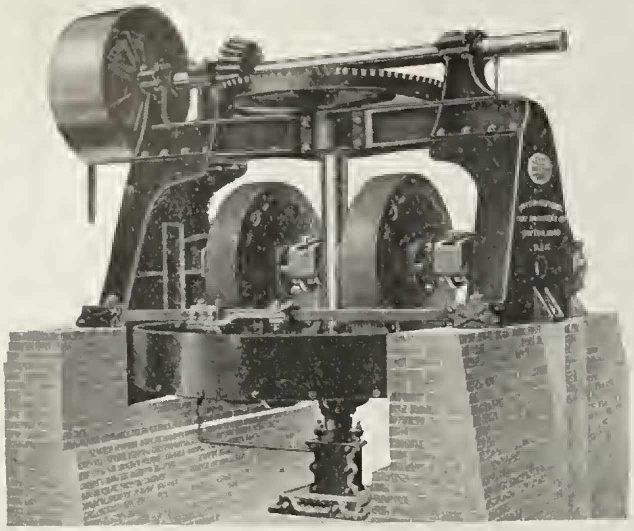


Save ½ Your Oil and Sand

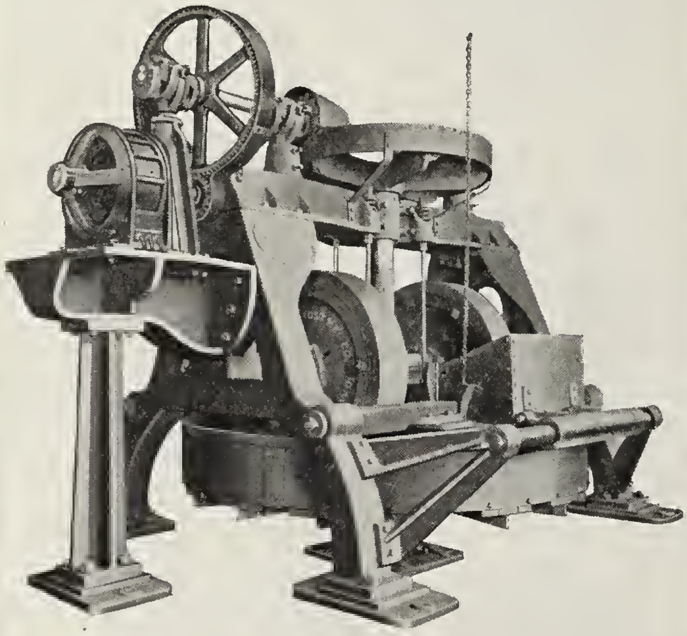
With International 5, 7, 8,—9 Foot Solid and Perforated Bottom Pans.

Let Us Crush Your Ganister, Flue Dust, etc.

INDUSTRIAL CARS

International Clay Mach'ry Co.
Dayton, Ohio, U. S. A.

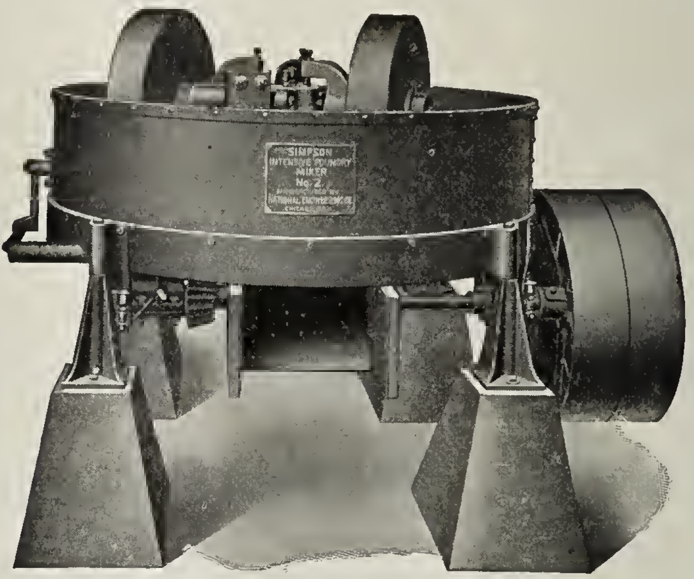
Frost
Wet Pan Sand Mill



The Frost Mfg. Co.
112 W. Adams St.
CHICAGO

THE SIMPSON
INTENSIVE FOUNDRY MIXER
Saves Both Sand and Labor

Improves the quality of the castings.
Corrects "scabbing" due to imperfect mixing of facing sand.
Saves compound when mixing core sand, and coal dust when mixing facing sand by reason of the thoroughness of its work.



The *Simpson Intensive Foundry Mixer* is in successful operation in some of the best known foundries in this country.

Write for detail and prices to

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PHILLIPS & McLAREN CO.
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We manufacture

Grinding Pans

of all types and sizes for Steel, Gray Iron and Malleable Foundries.

Eastern Sales Office,
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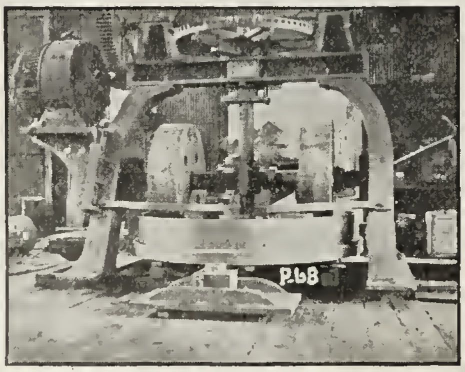
Philadelphia, Pa.



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Ohio Red,
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Silica, Core,
Fire, Bank,
Canadian,
Lake

Moulding Sand for Light and Heavy Casting

STOVE PLATE and BRASS

The Keener Sand & Clay Company

Dealer and Producer of All Grades of

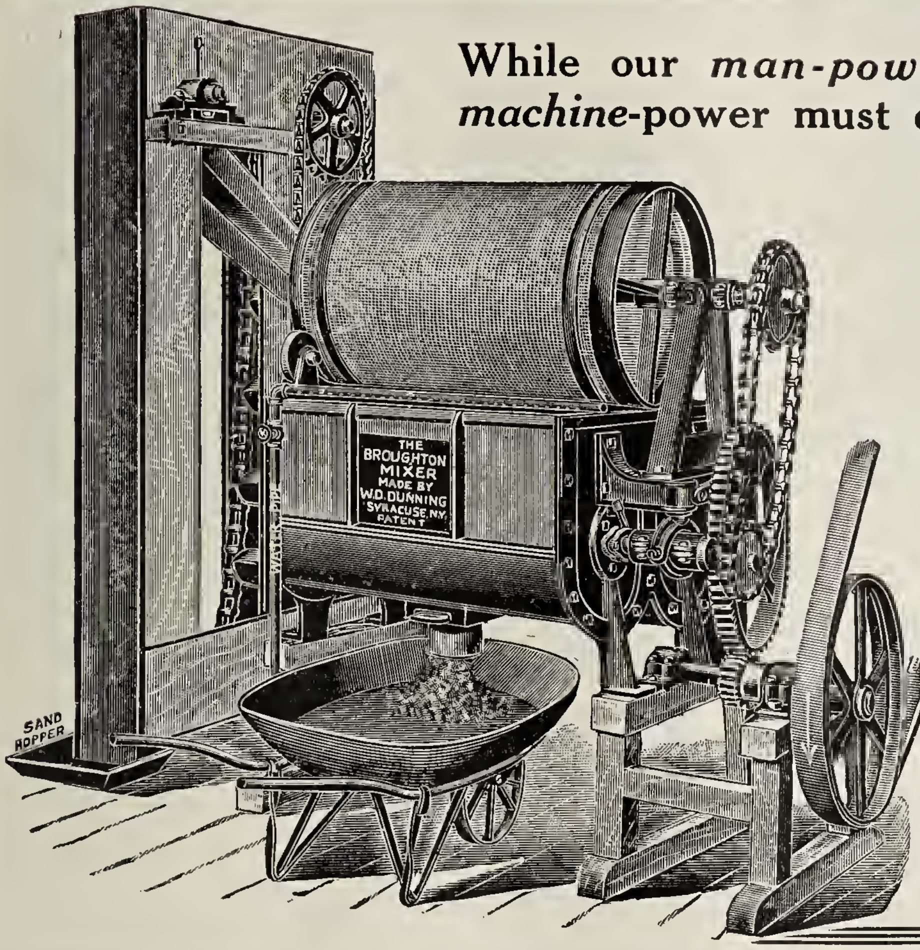
Sand and Fire Clay

Fire Brick of any Desired Shape

514 Hartman Building
COLUMBUS - OHIO

BROUGHTON CORE SAND MIXER

While our *man-power* is fighting Kaiserism, *machine*-power must do *its* bit.


THE BROUGHTON MIXER MADE BY W.D. DUNNING SYRACUSE, N.Y. PATENT
WATER PIPE
SAND HOPPER

The Broughton Core Sand Mixer takes the place of shovelers, riddlers and core sand mixers.

It is continuous and automatic in operation, elevating, screening and mixing the sand simultaneously.

You can easily and economically solve your labor shortage problem by installing a "Broughton" in your foundry.

Let us ship you one on trial.

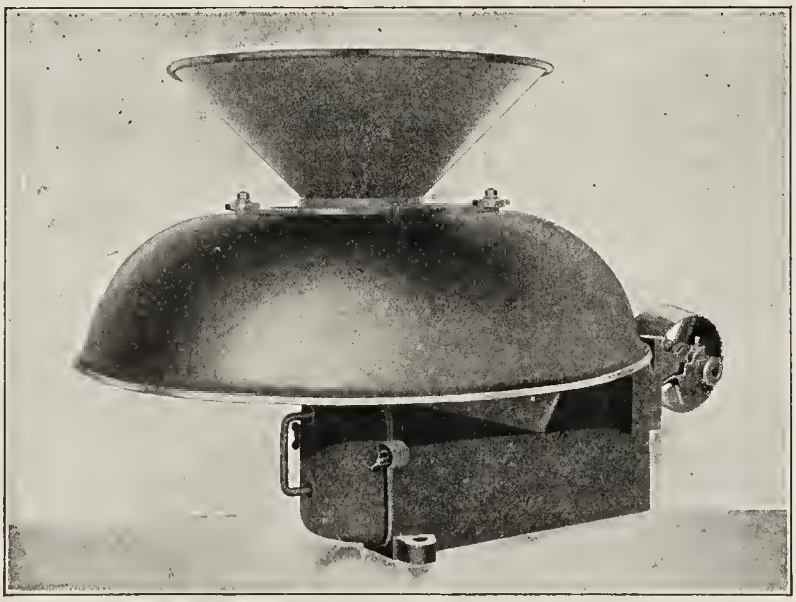
W. D. DUNNING
SYRACUSE - N. Y.

William Sellers & Co., Incorp., **Philadelphia, Pa.**

LABOR SAVING MACHINE TOOLS

OUR Centrifugal Sand Mixer disintegrates lumpy sand, thoroughly and quickly mixes all kinds of molding sand, core sand, and foundry mixtures, strengthens the sand and increases its porosity.

Its output may be roughly stated at about 10 tons per hour, but with mechanical means for conveying sand to and from the machine, this output may easily be materially increased. In our own foundry, two men working with the machine can do as much in three hours, as five men could do by the old method in ten hours.



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Put a money maker in your plant

The
STANDARD
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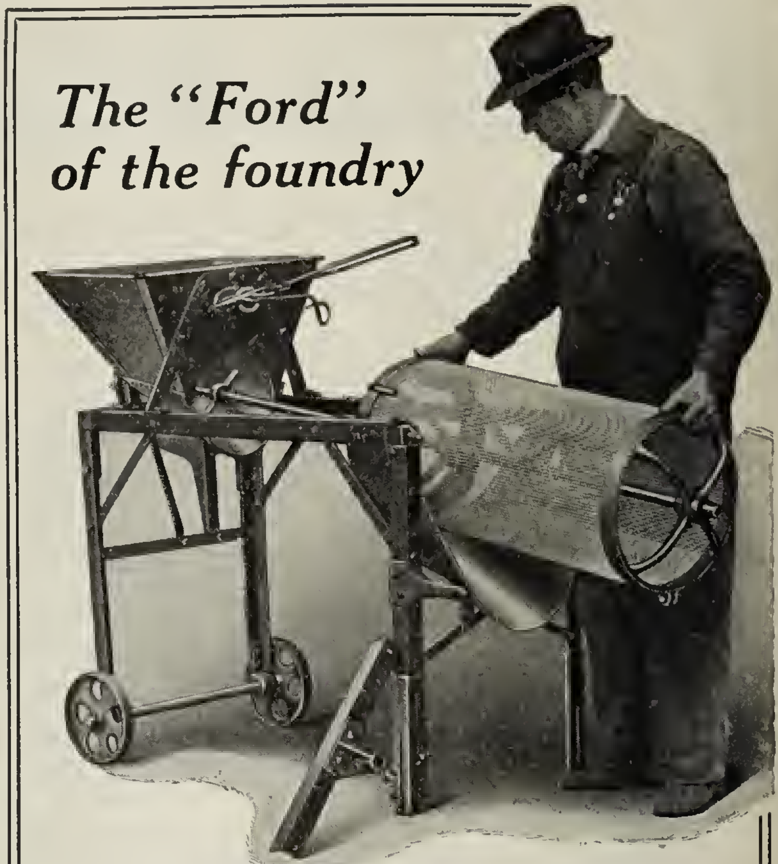
Capacities from 600 to 6,000 pounds of cinders, slag, skimmings, old crucibles, etc., per hour.
Requires but 2½ to 7½ h.p. to operate.
All hand sifting and washing eliminated.
Write for catalog.

The Standard Equipment Company
New Haven, Conn.
Manufacturers of Special Foundry Equipment



The "Ford" of the foundry

The Grand Rotary Sand Riddle
Simple—efficient—inexpensive.
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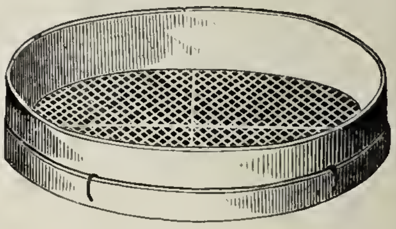

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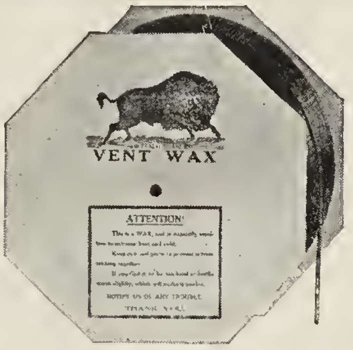

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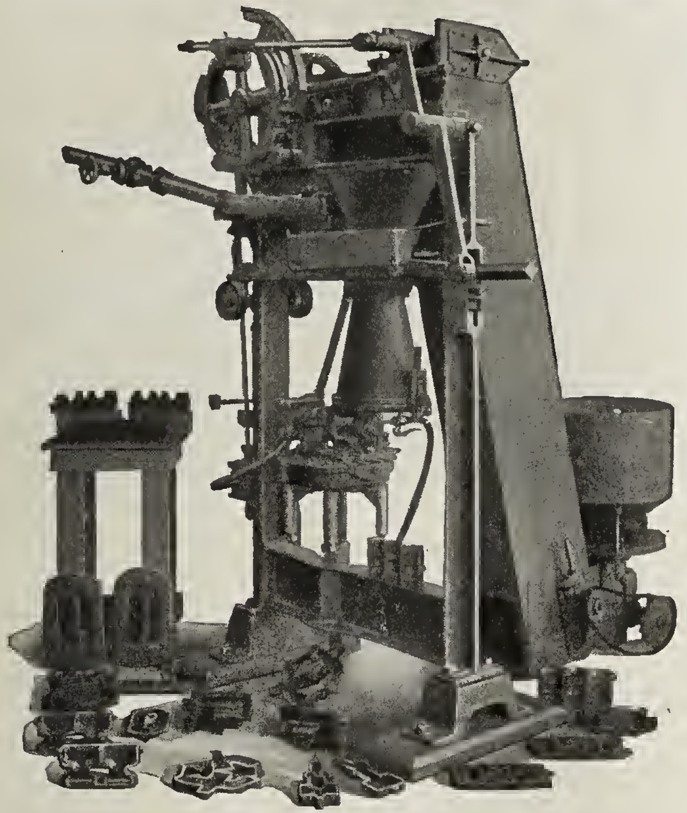

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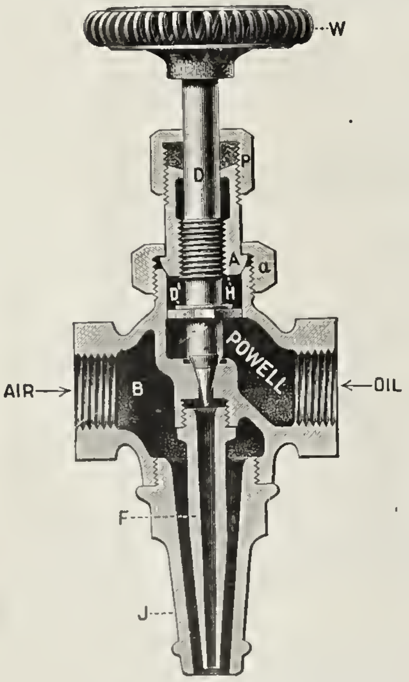

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Statement of the ownership, management, circulation, etc., required by the act of congress of Aug. 24, 1912, of The Foundry, published monthly at Cleveland, O., for Oct. 1, 1917. State of Ohio, county of Cuyahoga, ss. Before me, a notary public in and for the state and county aforesaid, personally appeared A. O. Backert, who, having been duly sworn according to law, deposes and says that he is the business manager of The Foundry, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of Aug. 24, 1912, embodied in section 443, Postal laws and regulations, to wit: 1.—That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Penton Publishing Co., Cleveland, O. Editor, A. O. Backert, Cleveland, O. Business manager, A. O. Backert, Cleveland, O. 2.—That the owners are: Names and addresses of stockholders owning or holding 1 per cent or more of the total amount of stock; John A. Penton, Cleveland, O.; Robert E. Power, Cleveland, O.; A. O. Backert, Cleveland, O.; C. J. Stark, Cleveland, O.; H. C. Estep, Cleveland, O.; O. P. Letchworth, New York, N. Y.; W. B. Ullman, Chicago, Ill. 3.—That the known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None. 4.—That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him. A. O. Backert. Sworn to and subscribed before me this fifth day of October, 1917. (Seal). Joseph D. Errico. (My commission expires June 30, 1918.)

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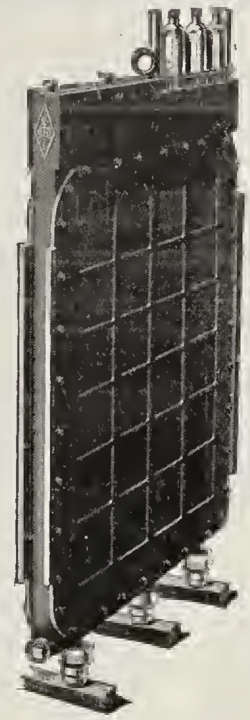

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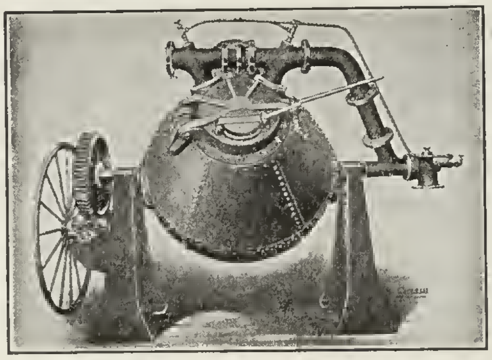

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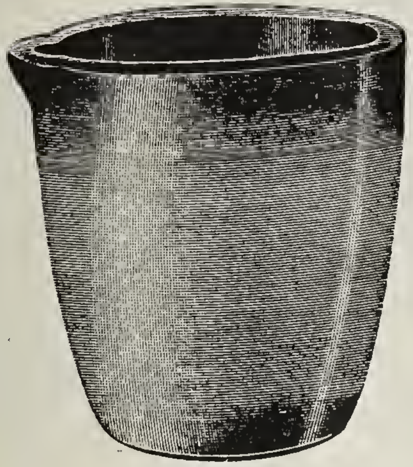

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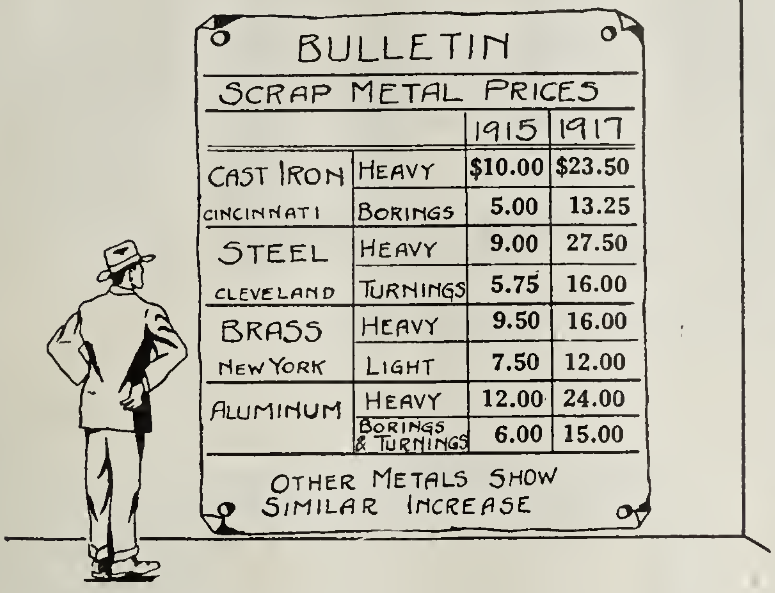

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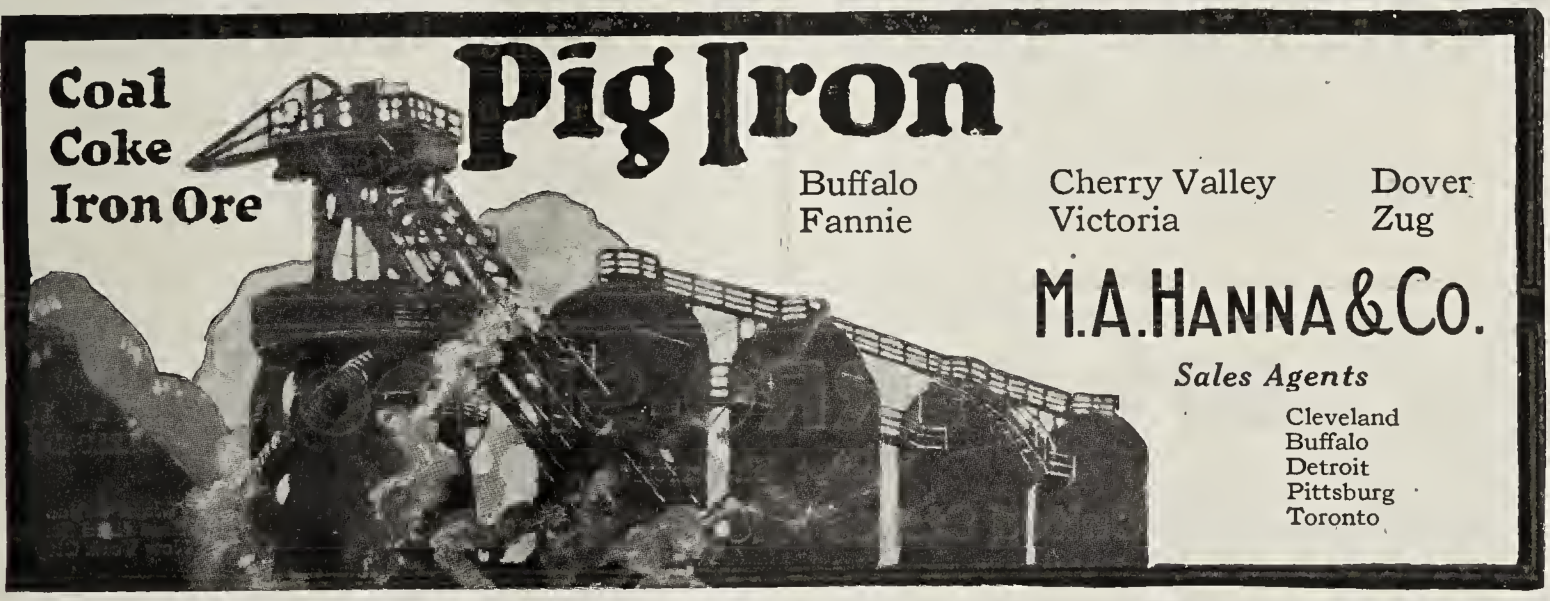

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Ferro-Manganese

J. H. Hillman & Sons Co.
STANDARD CONNELLSVILLE
LOW SULPHUR
FOUNDRY COKE
Oliver Building - PITTSBURGH, PA.

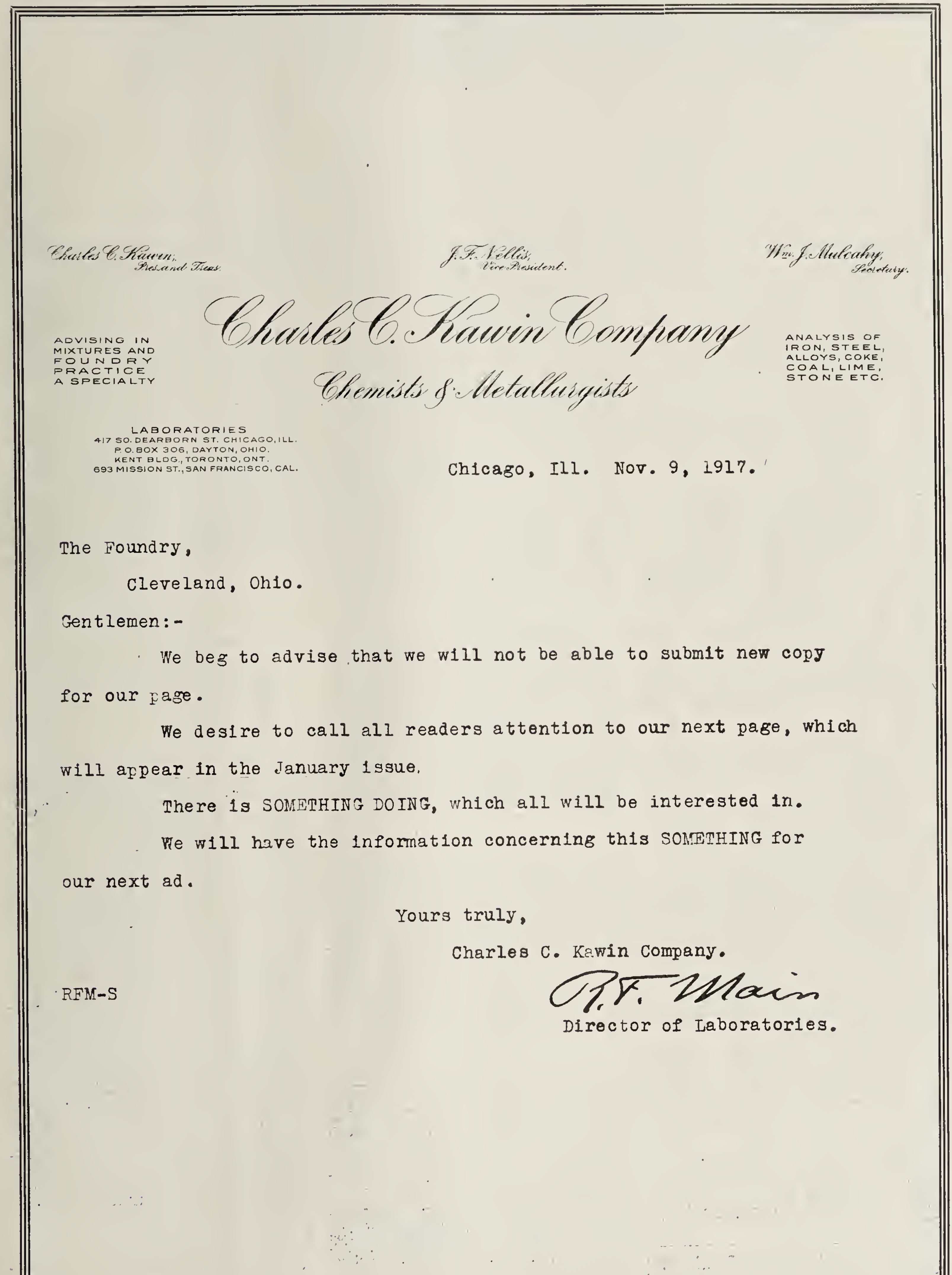
Pickands, Mather & Co.
IRON ORE
PIG IRON AND COAL
CLEVELAND, OHIO

McKeefrey & Co.
Pig Iron
Crushed Limestone
Coal and Connellsville Coke
LEETONIA, OHIO

Matlack Coal & Iron Corporation
PIG IRON
COAL AND COKE
NEW YORK PHILADELPHIA

Pilling & Crane
PIG IRON AND COKE
PHILADELPHIA NEW YORK

W. E. MOORE & CO.
ENGINEERS
Specializing on Electric Steel Furnace Installations, Heavy Electric Motor Drives, Power Plants and Efficiency Investigations.
Union Bank Building, PITTSBURGH, PA.



Charles C. Kawin, Pres. and Treas.
J. F. Nellis, Vice President.
Wm. J. Mulcahy, Secretary.

Charles C. Kawin Company
Chemists & Metallurgists

ADVISING IN MIXTURES AND FOUNDRY PRACTICE A SPECIALTY

ANALYSIS OF IRON, STEEL, ALLOYS, COKE, COAL, LIME, STONE ETC.

LABORATORIES
417 SO. DEARBORN ST. CHICAGO, ILL.
P. O. BOX 306, DAYTON, OHIO.
KENT BLDG., TORONTO, ONT.
693 MISSION ST., SAN FRANCISCO, CAL.

Chicago, Ill. Nov. 9, 1917.

The Foundry,
Cleveland, Ohio.

Gentlemen:-

We beg to advise that we will not be able to submit new copy for our page.

We desire to call all readers attention to our next page, which will appear in the January issue.

There is SOMETHING DOING, which all will be interested in.

We will have the information concerning this SOMETHING for our next ad.

Yours truly,
Charles C. Kawin Company.
R. F. Main
Director of Laboratories.

RFM-S

Classified Advertisements

Help and Positions Wanted—For Sale and Miscellaneous

RATES

"Help Wanted" Advertisements
4c per word—minimum advertisement—$2.00

"Position Wanted" Advertisements
4c per word—minimum advertisement—$1.00

"For Sale and Miscellaneous" Advertisements
8c per word—minimum advertisement—$2.00

IMPORTANT

Seven (7) words must be added for box address.

To insure insertion, advertisements must reach us by the 20th of the month.

Remittance should accompany order.

Help and Position Wanted advertisements should state whether—Gray Iron, Steel, Malleable or Brass.

Help Wanted

WANTED: — ALL-AROUND MAN CAPABLE of figuring costs to take charge of medium weight gray iron foundry located in Cleveland. Apply at once, stating wages desired. Address Box 415, THE FOUNDRY, Cleveland, O.

WANTED:—FIRST CLASS FOUNDRY foreman iron foundry, must have best of reference. Excellent opportunity for right man. Address Box 320, THE FOUNDRY, Cleveland, O.

SUPERINTENDENT: — MALLEABLE with knowledge of gray iron. Must be first class executive for position in middle west. H. H. Harrison & Co., Employment Agents, Association Bldg., Chicago, Ill.

WANTED: — FOUNDRY FOREMAN, must understand brass and aluminum; must give best of reference. Excellent position for the right party. Address Box 321, THE FOUNDRY, Cleveland, O.

WANTED:—WORKS MANAGER FOR large malleable foundry in Australia. Must have thorough and complete knowledge malleable castings and pattern making. One used to railway work preferred. Expenses paid. State experience and salary expected. Exceedingly good opening for right man. Address Box 319, THE FOUNDRY, Cleveland, O.

BRASS FOUNDRY. CAPABLE FOUNDRYMAN with small capital will be helped to start brass foundry. City's needs assure permanent business. Write Board of Commerce, Bradford, Pa.

FOUNDRYMEN WANTED: — GREEN Sand Molders and Laborers. 8-hour day. Time-and-a-half for overtime. Steady work. No labor trouble. Pond Works, Niles-Bement-Pond Co., Plainfield, N. J.

MEN WANTED TO LEARN AUTOMOBILE business in Detroit. Experience not necessary. Can earn good salaries with excellent chances for advancement. Address NATIONAL SERVICE BUREAU, 756 Woodward Ave., Detroit, Mich.

WANTED:—EXPERIENCED FOUNDRY foreman in agricultural implement works in the east. Address reply giving full particulars as to experience, salary expected, age, etc., this office. Address Box 359, THE FOUNDRY, Cleveland, O.

WANTED:—ASSISTANT TO GENERAL purchasing agent for manufacturing concern operating a number of plants in east. Should be familiar with purchase of iron, steel and general line of foundry supplies. Stating age, experience, qualifications and salary expected, address Box 383, THE FOUNDRY, Cleveland, O.

FOUNDRY SUPERINTENDENT:—MAN of executive ability and experience to superintend large jobbing foundry making machinery castings up to 15 tons. Capacity 1000 tons per month. Gray iron and semisteel. Address Box 405, THE FOUNDRY, Cleveland, O.

FOUNDRY FOREMAN:—STOVE AND furnace manufacturer in Central West has position for an experienced and competent foundry foreman. About 25 molders. Give age, experience, qualifications and salary expected. Address Box 113, THE FOUNDRY, Cleveland, O.

WANTED: — GOOD MACHINERY molders. Steady employment at good wages. No labor troubles. Cumberland Foundry & Mfg. Co., Nashville, Tenn.

WANTED:—FOREMAN FOR FOUNDRY making gray iron and semi-steel castings, employing 40 to 50 molders and helpers. Must be up to date, have had sufficient experience in floor and machine molding to know a fair day's work and able to show results. One who can mix by analysis preferred. Replies must state experience and salary required. Address Box 369, THE FOUNDRY, Cleveland, O.

WANTED:—STEEL CASTING SUPERintendent. A long established malleable iron foundry in a large city in the middle west, wants a thoroughly experienced superintendent for a 40 to 60 ton daily capacity steel foundry to be erected at once. Must be a man thoroughly familiar with up-to-date practice in producing converter and electric steel castings. Excellent and permanent position for high grade man. Give age and experience in applying for position. Application will be considered confidential if so requested. Address Box 368, THE FOUNDRY, Cleveland, Ohio.

WANTED:—YOUNG LIVE PATTERN MAKER—24 TO 28 YEARS OF AGE PREERRED—TO TAKE CHARGE OF FOUNDRY MELTING 10 TONS OF METAL DAILY. GOOD CHANCE FOR PERMANENT, WELL-PAYING POSITION. ADDRESS DRAWER U, WAYNESBORO, PA.

WANTED: — MALLEABLE FOUNDRY foreman, experienced in handling molders and labor. Must be able to judge malleable in all stages. Good position for the right man in an excellently equipped modern shop in central Illinois. Mention age, experience, references and salary expected. Address Box 365, THE FOUNDRY, Cleveland, O.

FOUNDRY FOREMAN WANTED FOR pump, air compressor, engine shop; a practical, thorough mechanic of pronounced, proven executive ability, with diplomacy necessary to successfully maintain and direct a modern 25-ton foundry to produce good castings at satisfactory cost with present equipment and available labor. Must have a full appreciation of value of time and shop economics, without frills. Tabulate on first page of letter age, nationality, education, experience, date and positions held with previous employers, expected compensation. State full particulars on following pages. Address Box 238, THE FOUNDRY, Cleveland, O.

FIRST-CLASS MOLDERS ON BRONZE statuary, also architectural bronze, for out of town, transportation provided; steady work, good pay. Address Box 371, THE FOUNDRY, Cleveland, O.

EXPERIENCED SALESMAN OF SANDblast machinery. State references and experience in application. Address Box 370, THE FOUNDRY, Cleveland, O.

WANTED:—BY A LARGE MANUFACturing concern, chemist who is familiar with laboratory work of malleable and gray iron foundry. State salary and experience. Address Box 361, THE FOUNDRY, Cleveland, Ohio.

WANTED:—A-1 FOUNDRY FOREMAN familiar with heavy railroad work. Only first-class man wanted. State age, salary wanted and references. Address Box 413, THE FOUNDRY, Cleveland, O.

WANTED:—SUPERINTENDENT FOR light gray iron foundry to take charge of plant and willing to make investment. Fair size shop, well equipped, situated in Cleveland. Address Box 416, THE FOUNDRY, Cleveland, O.

WANTED: — A WORKING FOREMAN for job foundry in West Virginia. Fine opportunity for competent Molder with ambition for advancement. Four other Molders now employed. Good town to live in. Address Box 423, THE FOUNDRY, Cleveland, Ohio.

WANTED:—FOUNDRY FOREMAN IN malleable plant. Must be competent, reliable, capable of handling men and getting results. State salary expected and references. Address Box 376, THE FOUNDRY, Cleveland, O.

WANTED:—A FOREMAN TO TAKE charge of turret lathes in brass finishing shop; one familiar with tool and metal pattern work. Address Box 377, THE FOUNDRY, Cleveland, O.

Wanted by

Aluminum Company of America,
Massena, N. Y.

Chemists for Laboratory, involving both routine and research work. Permanent positions are offerred with good pay. Write for further information.

SALESMAN WANTED:—EXPERIENCED in selling of light gray iron castings in territory between Chicago and St. Louis. Only experienced man desired with following among quantity users. Address Box 360, THE FOUNDRY, Cleveland, O.

WANT AN ENERGETIC AND PROGRESsive sober working foundry foreman, that will make nice stove castings in a well equipped foundry of less than 50 molders, located in a good town south of Philadelphia, near the Atlantic coast. State age, experience, condition of health, salary expected and when ready for duty. Address Box 363, THE FOUNDRY, Cleveland, O.

WANTED:—YOUNG MAN WHO HAS had annealing room experience in malleable foundry. Want man who can show and instruct how to properly pack castings. Foundry in middle west. State age, experience, nationality, salary. Address Box 411, THE FOUNDRY, Cleveland, O.

WANTED:—YOUNG MAN TO ASSIST foundry foreman in malleable foundry in Michigan. Must have experience in plate pattern and large production work. Must know how to instruct and break in apprentices. State experience, nationality, age, salary. Address Box 410, THE FOUNDRY, Cleveland, O.

CHEMISTS:—WE RAVE A GOOD POsition open for a reliable metallurgical chemist with foundry experience. Must be able to furnish satisfactory references. THE PISTON RING CO., MUSKEGON, MICH.

Lost

WANTED:—TO KNOW THE ADDRESS of Fred Stanley, brass molder, formerly with Cia. Fundicion de Fierro y Mfra., Monterey, Mexico. T. D. Buford, 135 East Main St., Chattanooga, Tenn.

Classified Advertisements

(Continued)

Positions Wanted

GENERAL MANAGER, QUALIFIED BY a broad experience in the efficient administration of the entire executive responsibility of the office end of foundry and machine corporations and with a liberal knowledge of factory requirements, is open to a permanent connection with reliable people, offering opportunity to utilize entire ability and general conditions justifying a change. Address Box 318, THE FOUNDRY, Cleveland, O.

FOUNDRY MANAGER OR SUPERINTENDENT owing to change in management, now open to engagement; 20 years experience on high grade work. Past 6 years Foundry manager for one of the large Automobile Companies. Understand the foundry business from A to Z in all its details. If interested, would be pleased to hear from you and furnish any particulars you may desire. Best of references. Address Box 339, THE FOUNDRY, Cleveland, O.

YOUNG FOUNDRY SUPERINTENDENT at present employed, would like to correspond with large auto or electric company, if in need of a practical and technical foundryman. Address Box 358, THE FOUNDRY, Cleveland, O.

PRACTICAL FOUNDRYMAN DESIRES position as foreman. Mix by analysis, know good cupola practice. Reliable, first-class reference. Address Box 181, THE FOUNDRY, Cleveland, O.

WANTED:—A POSITION AS FOUNDRY foreman. Previous experience, graduate of McLain system. Mix by analysis. Special study on gray iron and semisteel. Married; age 36 years. Address Box 395, THE FOUNDRY, Cleveland, O.

MALLEABLE SUPERINTENDENT, DEsires to make a change; am 41 years of age. Have 24 years of executive and practical experience as a foundryman. Conversant with all modern methods and thoroughly understand every detail of the malleable iron business. Address Box 403, THE FOUNDRY, Cleveland, O.

POSITION BY STEEL FOUNDRYMAN as foreman wishing to make change. Experienced on all kinds of light and heavy work; 12 years in steel foundry; 5 years as foreman molder; 34 years of age; married and of good habits. Adress Box 401, THE FOUNDRY, Cleveland, O.

A FOUNDRYMAN WITH 17 YEARS' experience as superintendent and foreman of foundry, pattern shop and molding machine production, salesman and expert at rigging up patterns and flasks for molding machines, is open for a permanent position as SALESMAN for molding machines or foundry supplies and tools or a first-class position in foundry making gray iron semi-steel, brass and bronze. First-class references. Position on Pacific coast only, considered. Address Box 400, THE FOUNDRY, Cleveland, O.

MOLDING MACHINE PATTERN FOREman of wide experience on general pattern work, wood and metal, wishes change. Formerly with Tabor Co. Address Box 399, THE FOUNDRY, Cleveland, O.

GENERAL SUPERINTENDENT AND manager. Man 36, good executive, 22 years' experience in the manufacture of heavy and light gray iron castings, both machinery and ornamental. Capable of handling every branch of a foundry business up to 50 tons capacity, from the office draughting room, pattern shop to foundry proper, offers services. Address Box 398, THE FOUNDRY, Cleveland, O.

ASSISTANT SUPERINTENDENT wants to change his position Jan. 1. Gray iron or steel. My references to reliable interested firm. Address Box 414, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS FOUNDRY foreman; 25 years experience in large or small gray iron foundry. A-1 references. Address Box 412, THE FOUNDRY, Cleveland, O.

FOREMAN PATTERN MAKER; 30 years experience. Desires change. Address Box 349, THE FOUNDRY, Cleveland, O.

FOUNDRYMAN NOW EMPLOYED DEsires change to open manufacturing shop operating or desiring molding machines. Technical education and fifteen years experience. Familiar with machine shop and pattern shop. Address Box 421, THE FOUNDRY, Cleveland, O.

GRAY IRON FOUNDRY SUPERINTENDent desires change; 25 years practical experience; thoroughly efficient with molding machines, match plates, cupola practice, dry and green sand or loam, heavy or light castings; mix by analysis, can read blue prints; have draftsman's experience and can efficiently break in unskilled labor. A-1 references. Address Box 298, THE FOUNDRY, Cleveland, O.

FOREMAN PATTERN MAKER OPEN for engagement, have had 24 years experience; 12 years as foreman; understand all molding machines and can get maximum work from men. Address Box 315, THE FOUNDRY, Cleveland, O.

FOUNDRY FOREMAN DESIRES change. Up-to-date on cupola practice. Molding machines and all classes of heavy and light castings. Address Box 292, THE FOUNDRY, Cleveland, O.

WOMEN COREMAKERS, TRAINED BY an expert foundryman. Position wanted in New England. Address Box 899, THE FOUNDRY, Cleveland, O.

WANTED:—POSITION AS FOREMAN in a Gray Iron Foundry; 23 years experience on light and heavy work and up-to-date on cupola and mixing of iron. Am at present employed as foreman but want to make change; 36 years of age. Prefer general jobbing or machinery. Address Box 300, THE FOUNDRY, Cleveland, O.

Gray Iron
Foundryman

Desires to make a change. Thoroughly experienced in gray iron, alloy metals and modern molding machine practice. Want a big job that can only be handled in a big way. Address Box 386, THE FOUNDRY, Cleveland, O.

POSITION WANTED BY A FIRST-class foundry foreman, gray iron or malleable, mix by analysis and make semi-steel. Address Box 388, THE FOUNDRY, Cleveland, O.

FOREMAN PATTERNMAKER; 26 years varied experience. Engines, tools, machinery, light and heavy molding machine methods, capable executive, highest references. Age 42. Address Box 389, THE FOUNDRY, Cleveland, O.

PATTERNMAKER FOREMAN DESIRES change, account residence location. Successful experience in agriculture machinery and molding machines. Address Box 390, THE FOUNDRY, Cleveland, O.

POSITION AS FOREMAN BY AN A-1 molder on furnace machinery and machines, good rigger, competent handler of men. Will guarantee production, mix by analysis, understand cupola thoroughly. Address Box 391, THE FOUNDRY, Cleveland, O.

WANTED:—POSITION AS FOREMAN or assistant by a good molder; 25 years experience on all classes of work. McLain graduate. Age 38, prepared to make good. A-1 references. Address Box 392, THE FOUNDRY, Cleveland, O.

FOUNDRY SUPERINTENDENT; 35 years experience in architectural, statuary, chandelier and lost wax-work. Best reference. Address Box 393, THE FOUNDRY, Cleveland, O.

FOUNDRY FOREMAN OPEN FOR ENgagement, practical in all departments of gray iron, including cupola. American, age 47, references. Address Box 193, THE FOUNDRY, Cleveland, O.

FOUNDRY SUPERINTENDENT, PRACTICAL, EXPERIENCED MAN, DESIRES CHANGE; ENERGETIC AND RESOURCEFUL; PREFER SHOP MAKING CASTINGS FROM BENCH WORK TO 6000 POUNDS; MIX IRON BY ANALYSIS AND CAN PRODUCE SEMI-STEEL; MARRIED MAN, BEST REFERENCE AS TO CHARACTER AND ABILITY. McLAIN GRADUATE. ADDRESS BOX 408, THE FOUNDRY, CLEVELAND, O.

AS PLANT MANAGER OR SUPERINtendent of manufacturing plant producing duplicate work. Twenty years experience handling machine shop, pattern shop, and foundry. Address Box 420, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS FOUNDRY foreman. Up-to-date on match plates, machines and all improved methods. Stove shop preferred. Address Box 322, THE FOUNDRY, Cleveland, O.

WANTED:—POSITION AS FOREMAN in Gray Iron jobbing shop. Special cupola practice; mix by analysis, molding machine experience; 36 years; married, temperate. Best references. Address Box 332, THE FOUNDRY, Cleveland, O.

WANTED BY A YOUNG MAN 34 years old, position as steel foundry foreman on converter or Open Hearth processes, recently employed with large concern as Dry Floor Foreman; 16 years practical experience, best of references. Open shop preferred and will furnish the men. Address Box 237, THE FOUNDRY, Cleveland, O.

WANTED:—MOLDER A-1 MECHANIC, graduate of special foundry course, best references, desires position as foreman, ambitious and temperate. Salary no object, but chance to make good. Address Box 372, THE FOUNDRY, Cleveland, O.

PRACTICAL FOUNDRY SUPERINTENDENT AND WORKS MANAGER NOW EMPLOYED, DESIRES CHANGE. HIGH EXECUTIVE, UNSURPASSED REFERENCES AS TO CHARACTER AND ABILITY. EXCEPTIONAL ABILITY TO HANDLE MEN, ORGANIZE SYSTEM. INCREASE OUTPUT AND REDUCE COST. ADDRESS BOX 375, THE FOUNDRY, CLEVELAND, O.

SUPERINTENDENT OF STEEL FOUNDRY desires change. Competent executive of experience, temperate, references. Best sand and steel mixtures. Can reduce excessive risers, eliminate blow holes. Address Box 373, THE FOUNDRY, Cleveland, O.

BRASS FOREMAN WANTS POSITION as assistant superintendent or foreman; 27 years experience in several lines of brass foundry practice; competent executive; A-1 references. Address Box 374, THE FOUNDRY, Cleveland, O.

CAPABLE GRAY AND MALLEABLE iron executive, now in charge of large foundry, desires change. Prefer position offering future for man of ability. Address Box 382, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS FOUNDRY SUperintendent or foreman. Services available January 1. Modern, up-to-date executive. References from past employers. Address Box 378, THE FOUNDRY, Cleveland, O.

WANTED:—POSITION AS ASSISTANT superintendent in foundry making auto castings. Mechanical expert, trouble man on the equipment and foundry trouble, and getting equipment into production. Have been with one of the largest auto casting foundries in the country for the past five years, as superintendent of the pattern and machine shop equipment and foundry trouble. Would consider making an investment in foundry going into this line of work. Know how to push and get results at the same time. Address Box 380, THE FOUNDRY, Cleveland, O.

A MAN 35 YEARS OF AGE, DESIRES position as superintendent or assistant of cast iron or malleable foundry; 15 years practical experience, also technical training. Up-to-date on molding machines, mixing iron by analysis and cutting scrap loss. Best of references. Open shop preferred. Address Box 379, THE FOUNDRY, Cleveland, O.

COREROOM FOREMAN NOW EMployed wants to make a change; 13 years at the business on all classes of work, studying to become a general foundryman, wants a chance to rise to the top. Address Box 381, THE FOUNDRY, Cleveland, O.

Classified Advertisements

(Continued)

Positions Wanted

FOUNDRY SUPERINTENDENT OR foreman with 15 years experience all classes of work. Up-to-date on modern foundry practice, capable handler of men. Best of references. Address Box 394, THE FOUNDRY, Cleveland, O.

POSITION WANTED BY PRACTICAL gray iron foundry foreman. Can take entire charge of medium or large shop doing jobbing or any high-grade work. Broad experience on heavy and light machinery or engine. Address Box 407, THE FOUNDRY, Cleveland, O.

ATTENTION!
FOUNDRY
OWNERS!

Every McLain graduate has a pocket diploma. Ask for it when considering applicant in your foundry—or write direct when in the market for up-to-date foremen or superintendents, to McLAIN'S SYSTEM, INC., Goldsmith Bldg., Milwaukee, Wis. NO CHARGE.

WANTED:—POSITION AS FOREMAN in gray iron foundry on light and heavy work. Experienced, understand mixing metal by analysis. Up-to-date cupola practice. Prefer machinery, gas, steam, engine or general jobbing shop. Understand machine, bench, floor and crane work; age 45. Address Box 387, THE FOUNDRY, Cleveland, Ohio.

GRAY IRON FOUNDRY SUPERINTENDENT desires change; 12 years practical experience, thoroughly efficient with molding machines, match plates and cupola practice. Address Box 367, THE FOUNDRY, Cleveland, O.

MECHANICAL ENGINEER:—TWELVE years practical experience with open-hearth furnace and rolling mill, desires position as chief draftsman or chief engineer. Address Box 417, THE FOUNDRY, Cleveland, O.

AS FOUNDRY SUPERINTENDENT. Molding machine shop preferred. Experienced in drafting room, machine shop, and pattern shop as well as in foundry. Address Box 419, THE FOUNDRY, Cleveland, O.

POSITION WANTED AS FOREMAN OR assistant in either malleable or gray iron foundry. Young energetic foundryman. Address Box 422, THE FOUNDRY, Cleveland, Ohio.

GRAY IRON FOUNDRYMAN WANTS position as foundry or cupola foreman; university education, chemist; can make semi-steel and handle help efficiently. Excellent cupola practice. Address Box 406, THE FOUNDRY, Cleveland, O.

FOUNDRY SUPERINTENDENT:—CAN mix and melt iron scientifically and make semi-steel. Can install cost system and locate foundry leaks. Address Box 397, THE FOUNDRY, Cleveland, O.

FOUNDRY MANAGER OR SUPERINTENDENT wishes to make change. Experience covers iron, side blow converter, steel. Correspondence confidentially invited. Address Box 396, THE FOUNDRY, Cleveland, O.

GRAY IRON FOREMAN WANTS AN opportunity; thoroughly experienced with cupola practice, gray iron casting, stove plate, auto cylinders and jobbing. A-1 references. Address Box 366, THE FOUNDRY, Cleveland, O.

ELECTROMETALLURGICAL ENGINEER, college graduate; 10 years experience in design and operating of electrical steel furnaces, wishes to connect with reliable concern. Address Box 277, THE FOUNDRY, Cleveland, O.

WANTED:—POSITION AS FOUNDRY foreman by first-class man with five years experience as foreman on light, medium and heavy gray iron castings. Address Box 385, THE FOUNDRY, Cleveland, O.

STEEL FOUNDRY GENERAL MANAGER, age 35, now employed, desires new connection. Converter, open-hearth or electric practice. Prefer percentage arrangement based on profitable results, not on large quantities of poor molds or scrap. Full and thorough investigation solicited. All replies kept confidential. Address Box 402, THE FOUNDRY, Cleveland, O.

POSITION AS SUPERINTENDENT:—A healthy, sober, non-union gray iron foundryman now employed wants a change. Fifteen years experience. Mix iron by analysis, up-to-date on cupola, molding machines, core room, brass foundry. Expert melter of semi-steel. Address Box 404, THE FOUNDRY, Cleveland, O.

CORE ROOM FOREMAN WANTS TO make a change; seven years experience in malleable and gray iron. Age 29. Address Box 384, THE FOUNDRY, Cleveland, O.

MALLEABLE FOUNDRY SUPERINTENDENT or assistant general manager; 10 years thorough practical experience in all branches of malleable production. General engineering and metallurgical training. Highest credentials. Address Box 362, THE FOUNDRY, Cleveland, O.

GRAY IRON FOREMAN WANTS SHOP JOB; THOROUGHLY EXPERIENCED. NOW WITH WORCESTER, MASS., POLYTECHNICAL INSTITUTE; HUSTLER AND CAN HANDLE MEN WITH SUCCESS TO GET PRODUCTION. ADDRESS BOX 323, THE FOUNDRY, CLEVELAND, OHIO.

GRAY IRON FOUNDRY SUPERINTENDENT, now in charge of foundry in middle West, employing between 500 and 600 men. Melting from 125 to 150 tons of metal per day, desires change after first of year. 25 years practical experience on green sand, dry sand, skin dried work and sweep work of all descriptions, efficient with molding machines and cupola practice. Can break in and handle unskilled labor. Address Box 418, THE FOUNDRY, Cleveland, O.

Service that Really Serves

When wanting help or a position, or desiring to sell or buy second hand equipment THE FOUNDRY will give you unsurpassable service.

Here's the kind of results you get:

I wish to compliment you on the efficiency of your publication as an advertising medium.

Through the ad. in THE FOUNDRY the writer has obtained the position of General Manager of the Edward Maher's Sons foundry at Newark, N. J., and will take up his new duties at once. Was formerly with Wheeling Mold & Foundry Company, of Wheeling, W.Va.

John D. Miller, Newark, N. J.

The object of this letter is to advise you of a change in my address and to thank you for the excellent results I am enjoying under this change, which I obtained from my ad. in THE FOUNDRY. It was more than I anticipated to receive seven replies to one advertisement. I have found through experience that THE FOUNDRY beats them all as an advertising medium. Thanking you for the prompt and courteous letters, I beg to remain,

Thos. E. LaMondy, Milwaukee, Wis

We desire to thank you for your promptness in giving us the name of the French Oil Mill Machinery Co., who had advertised a cupola with you. We have written these people, but evidently your service was good, because the cupola has been sold.

C. E. Prince & Co.
Philadelphia, Pa.

We do not wish you to continue the ad. which we had in last month's issue of THE FOUNDRY as the results we looked for have been obtained to our highest satisfaction. It is very evident that THE FOUNDRY is read in all sections of the country, judging from the answers we received from this ad.

Union Foundry Co., Fitchburg, Mass.

I thought it might interest you to know the results from my ad. for a brass foundryman.

I received one answer to this from Australia, one from England, two from Canada and thirty-one from almost as many different states of the union. The man I picked as the most promising was in Sacramento, Cal. He has been with me a week now and I think he is going to prove just the man I was looking for.

H. H. Miller, Torreon, Coah., Mex.

Forms close the 20th of the month.

Better let us have your copy now, so as to be ready for the next number.

Classified Advertisements

(Continued)

Foundries Wanted For Sale or Lease

FOUNDRY AND MACHINE SHOP FOR sale. Well equipped foundry and machine shop, now in operation at Billings, Montana. Large exclusive territory in farming, mining, gas and oil section. Good railroad facilities and splendid home market. Address P. O. 1018, Billings, Montana.

FOR SALE OR LEASE:—STOVE FOUNDRY in heart of Chicago, thoroughly equipped and with established business of long standing. Owner wishes to retire. SUPERIOR STOVE WORKS, Chicago, Ill.

Wanted

SECOND-HAND ROOTS BLOWERS
Will purchase or exchange for new Machines any Roots Blowers. H. M. Papworth, 120 Liberty St., New York City.

WANTED:—FORTY-TON BOTTOM poured steel foundry ladle, new or second hand. Address United Engineering & Foundry Co., Farmer's Bank Bldg., Pittsburgh, Pa.

SECOND-HAND FOUNDRY EQUIPMENT wanted, including cupolas, ladles, tumbling barrels, etc. Quote price and state condition. Address Box 314, THE FOUNDRY, Cleveland, O.

WANTED:—CUPOLA ABOUT 60 inches in diameter, suitable blower and sand blast. For sale 43-inch Colliau cupola, No. 4 Roots blower serial No. 25447, and No. 6 Roots blower. Levering Bros., Baltimore, Md.

WANTED:—USED MOTOR OR BELT-driven roll lathe, 18 inches or smaller. Should be equipped for necking and turning. HUBBARD STEEL FOUNDRY CO., 502 Granite Bldg., Pittsburgh, Pa.

Opportunities

NOTICE TO ALL FOUNDRYMEN
We have not sold or licensed any one to install the original Zippler Tuyere System. Any one installing same do so at their own risk. Write us for full details.

M. ZIPPLER & SON
1714 Liverpool St., N. S., Pittsburgh, Pa.
8 E. Terrace St., Chattanooga, Tenn.

For Sale

FOR SALE:—20,000-LB. LADLE. PERFECT condition. Fairmount Foundry Co., Olney, Philadelphia, Pa.

FOR SALE:—TWO INGERSOLL-RAND 13 x 12 Imperial type "X" compressors, 40-pound and 100-pound machines. Address Box 316, THE FOUNDRY, Cleveland, O.

FOR SALE: — BROWN PATENT TWO rope grab bucket, 70 cubic feet. Net weight, 5,200 lbs. Address Box 310, THE FOUNDRY, Cleveland, O.

FOR SALE:—ONE NO. 6 AND ONE No. 4 Whiting cupola, one 4-ton and one 6-ton spur-geared ladle. One No. 10 Buffalo blower, and one No. 6-B Wilbraham-Green blower. Five Adams hand squeezers. The Federal Foundry Supply Co., Milwaukee, Wis.

FOR SALE:—THREE MODEL E. HAND squeezer split pattern molding machines, with lifting device, and two vibrators less top plate; 40 finished flasks 24 inches x 10½ inches x 2⅞ inches. 20 flasks 24 inches x 10½ inches x 2⅞ inches, not machined. For prices, etc., address The American Pin Company, Waterville, Conn.

For Sale

HEAVY DUTY WAGNER COLD SAW for sale, as good as new; first reasonable offer will be accepted. Hill-Curtis Co., Kalamazoo, Mich.

GRAY IRON CASTINGS

500 to 1500 Pounds

MACHINE WORK

Best of service assured. Inquiries solicited. The Scheidler Machine Works, Co., Newark, Ohio.

FOR SALE:—MACHINE SHOP PLANER; bed 2 feet by 8 feet, double speed on the reverse. One 42-inch Schwartz oil burning furnace. Belfast Foundry & Machine Co., Belfast, Me.

FOR SALE:—COOMB'S GYRATORY riddle 220 volt D. C. Used six months, perfect condition. Price $85. Griffin Wheel Co., Chelsea, Mass.

FOR SALE:—TWO FOUR-TON BOTTOM pour ladles; practically new, having been used only 60 days. Good condition—selling account of changing to larger ladles. AMERICAN MACHINE & MANUFACTURING CO., Atlanta, Ga.

FOR SALE:—48-IN. DIA. x 23 FT. closed tank, 5/16-inch iron, $250. Fine order. Was a car tank, has lugs on side, dome on top and manhole.

J. L. Lucas & Son, 3 Fox St.,
Bridgeport, Conn.

FOR SALE:—ONE 3-TON WORM geared Whiting crane ladle. As good as new. J. H. Leege, 218 Vine St., Waterloo, Iowa.

Free Ad Service

We maintain a Service Bureau to write Want-ads for every classification. If you haven't time to prepare your ad WE'LL write it for you, and "dress it up" in a way that will get attention.

Put our want-ad man

On the Job

48

Immediate Shipment

1—60 x 90 ft. with two crane runways, 30 ft. clearance, 18 ft. square cupola charging platform, frame lean-to at one end 40 x 60 ft.
1—70 x 145 ft., 29 ft. clearance, covered all around with heavy corrugated galvanized sheets.
1—86 x 152 ft. Monitor roof.
1—61 x 151 ft. Monitor roof with lean-to 30 ft. wide.
1—80 x 130 ft. Monitor roof with lean-to 36 ft. wide.
1—60 x 160 ft. equipped with brand new 30 ton crane, with saw-tooth bays, also equipped with runways, unit system, these buildings fully enclosed.

FOUNDRY PLANTS

Foundry plant 4 acres—78,000 sq. ft. floor space. Main line Penn. R. R. formerly stove mfg. plant, eastern central Ohio.
Foundry and machine shop plant, all or part of 21 acres. B. & O., N. & W. and Belt Line R. R. Cincinnati district, suitable for large engine building or machinery.

Roots—Connersville Blowers

New and used

1—No. 6 Roots 38.5 cu. ft. capacity per revolution.
1—No. 2 Roots 4 cu. ft. 2 pounds pressure.
Ventilating fans.
Exhaust fans.
Sturtevant and Buffalo pressure blowers.
1—No. 5 Baker 19 cu. ft.
1—Connersville 33 cu. ft.
1—Piqua 48 cu. ft.
2—No. 7½ Baker 70 cu. ft.
2—No. 5 Wilbraham 19 cu. ft.
1—No. 3 Roots 8.3 cu. ft.
1—No. 3 Roots Special 5 cu. ft.
2—No. 7 Roots 61.6 cu. ft.
1—No. 5 Roots 19.6 cu. ft.
2—No. 1 Roots 2.95 cu. ft.
Also variety small blowers for oil or gas furnaces, and fan blowers.

Air Compressors and Receivers

1—8 x 8 in. Ingersoll-Rand belted type. Send for special prices naming requirements.
1—36 in. x 5 ft. high pressure tank.

Cupolas—Converters

1—60 in. shell Whiting.
1—108 in. shell Whiting.
1—60 in. shell (special constructed).
1—66 in. shell Colliau complete except stack.
1—No. 3 Whiting. Quantity 15 in. wind piping.
1—No. 4 Whiting.
1—90 in. shell, extra high stack.

Cranes—Jib and Traveling

Send your specifications stating particulars. Can furnish jib and traveling cranes, wide range of sizes.
Jar ram core plate 18 in. square.
2—Arcade "air squeeze" molding machines.
1—Standard core sand mixer.
1—5-ton electric hoist 220 volt D. C.
1—1-ton Sprague hoist 220 volt D. C.
1—7-ton geared ladle, also 1½, 2, 2½, 3, 3½, 4½, 5 tons.
1—15-ton reservoir ladle.

ELEVATOR AND HOISTING OUTFITS
220-volt motor driven worm geared drums.
Belted worm geared winding drums.

BRASS MELTING FURNACES, OPEN FLAME TYPE
Low operating cost, no crucible needed.

OXY-ACETYLENE CUTTING AND WELDING GENERATORS
Supplies, torches, lowest prices, best quality. General line of Foundry Equipment, machinery, motors, Power Equipment. We buy and sell.

THE CLIFTON-PRATT CO.,
CINCINNATI, OHIO.

Classified Advertisements

(Continued)

ELECTRIC CRANES

4—10 ton Electric Traveling Cranes, 72' span. Three of the above are equipped with two 5 ton trolleys each and one has four motor single trolley.

1—10 ton, 3 motor, Electric Traveling Crane, 24' span.
2—20 ton Jib Cranes.
2—1 ton Traveling Wall Cranes, complete with 1 ton Sprague Hoist and 200′ runway.

CUPOLAS

1—84″ Whiting.
1—72″ Whiting.
1—56″ Whiting.
1—54″ Colliau.
1—41″ Whiting.

CORE OVENS

1—Battery Drawer Type Ovens, consisting of three Sections containing Four Drawers Each.

LADLES

3—20 ton Spur Geared, bottom Tap.
1—20 ton, Worm Geared.
1—15 ton, Worm Geared.
1—10 ton, Spur Geared.
1—6 ton Reservoir.
1—3 ton.
1—1½ ton.
2—1 ton.

MOULDING MACHINES

2—10″ Tabor Power Squeezers.

BLOWERS

2—No. 7 Roots, Positive Pressure.
1—No. 6A Wilbraham-Green, Positive Pressure.
1—No. 5A Wilbraham-Green, Positive Pressure.
1—No. 5B Wilbraham-Green, Positive Pressure.
1—No. 4½ Baker.
1—No. 4 Roots.
1—3.3. Connersville.
1—No. 70 Connersville.
2—No. 1 Garden City, Positive Pressure.
2—No. 2 Garden City, Positive Pressure.

AIR COMPRESSORS

1—2500 cu. ft. Laidlaw-Dunn-Gordon.
1—100′ Chicago Pneumatic, Steam.
1—8 x 8 Bury, Belt Driven.
1—10 x 10 Curtis, Belt Driven.
1—11½/6 x 12 Compound, High Pressure, complete with Unloader, Air Tank and all Fittings.
1—3 x 10 Air Receiver, 150 lb. pressure.

Miscellaneous and Foundry Equipment

1—Type M1 Dings Magnetic Separator.
1—26 x 54 Tumbler.
1—No. 1 Standard Sand Mixer.
3—No. 1 Coke Fired Brass Furnaces.
1—60″ Schwartz Furnace.
2—Heavy Grinders.
28—Foundry Trucks, Flat Wheel Type.
1—48 x 48 x 18 Bement Planer.
1—6′4″ x 14′ Planer.
1—13′ Atlas Boring Mill.
3—Curtis Pipe Threading Machines, thread up to 8″.
1—Revolving Derrick, Steam Operated.

In addition to the above equipment we have a large quantity of other material on hand for the equipment of Foundries and Machine Shops.

SCULLY-JONES & CO.

Complete Foundry Equipment

RAILWAY EXCHANGE BUILDING CHICAGO, ILL.

WE HAVE FOR IMMEDIATE SALE and prompt shipment the following equipment:

1—30 x 45 "Herman" Jar Rollover Molding Machine. In perfect working condition. Latest type. Has been in use about three months.
1—30 x 45 "Herman" Jar Rollover Molding Machine. In perfect working condition. Has been in use for two years, but has been entirely overhauled.
1—24 x 30 "Herman" Plain Jarring Machine. In perfect working condition. Has been used for one month.
1—36-in. "Pridmore" Hand Rammed Stripping Plate Molding Machine. In perfect condition.
1—52-in. "Pridmore" Hand Rammed Stripping Plate Molding Machine. In perfect condition.
1—Model "E" Berkshire Hand Squeezer. In good condition.

These machines have been discarded owing to change in line of work. Attractive prices for quick sale. Address Box 239, THE FOUNDRY, Cleveland, O.

CUPOLAS AND BLOWERS

One No. 3 46 inch Whiting cupola.
One No. 6 66 inch Whiting cupola.
One No. 9 84 inch Whiting cupola.
One No. 12 108 inch Whiting cupola.

Rotary Pressure blowers, displacement 101 feet, 60 feet, 45 feet per revolution.

Hugh W. Dyar, 140 So. Dearborn St., Chicago.

FOR SALE:—CUPOLA 51-INCH SHELL in good condition, reasonable. THE BUCKEYE PRODUCTS CO., CINCINNATI, O.

FOR QUICK SALE!!

1-10 ton Whiting 2-motor electric traveling crane;

48′ 8″ span; floor operated; built up girder, fishbelly type. 220 volt D. C. motor on bridge travel. Trolley operated by hand chain from floor. Equipped with flush type bridge trucks and 160 ft. of steel runway.

54—Jib cranes; all sizes; all styles.

Write for Blue Prints

HOISTS

One 3-ton Shepard electric hoist with trolley attached, to run on lower flange of 15-inch I-beam. Lift 15 feet, 7/16 inch cable, complete with 4 H. P. Crocker-Wheeler motor.

GRINDER:

One double end Safety Wheel Co. heavy grinder. Shaft 2-inch diameter, 84 inches long. Driving pulley in center.

SAW:

One Higly Machine Co. No. 21 cold saw; slotted adjustable table 24 inches x 27 inches; saw 24 inches x 26 inches in diameter.

Ask for our latest Foundry, Supply and Equipment Price Wrecker No. F-304 FREE!

HARRIS BROTHERS CO.,
35th and Iron Streets,
Chicago, Illinois.

ONE NUMBER 8, TYPE A. G. PANGBORN SAND BLAST MACHINE. NEW — NEVER USED. ADDRESS BOX 243, THE FOUNDRY, CLEVELAND, O.

GRAPHITE:—CEYLON; THE HIGHEST quality. Imported before the war; about 10,000 pounds. Best for crucibles and other purposes. Three upright engines about 14 H. P., good order. CODD TANK & SPECIALTY CO., BALTIMORE, MD.

ONE NO. 0 WHITING CUPOLA, NEW. Never used; too small for our present requirements. The Nash Motors Co., Kenosha, Wis.

FOR SALE AND IMMEDIATE DELIVERY. One Tabor 24-inch hinged molding machine, 7-inch draft, No. M 5230, 2 elastic clamps, one 1⅛ foot drop forged vibrator No. 3446. One H. E. Pridmore molding machine, 8-inch draw, double shaft, size 30 x 30. One Sellers sand mixing machine. Hewes & Phillips Iron Works, Newark, N. J.

BLOWERS

FOR SALE

No. ½ and No. 5 Roots blowers.
No. 3, No. 4 and No. 6 Roots exhausters.
No. 4 and No. 6 Sturtevant blowers.
No. 2 Green blower.
No. 3 and No. 5 Baker blowers.

Six cubic feet; 10 cubic feet and 24 cubic feet per revolution Connersville blowers.

Electric motors, etc.

J. W. ADAMS

130 North St., Philadelphia, Pa.

McCORMICK'S FOUNDRY EQUIPMENT BARGAINS

CUPOLAS

32", 33", 36", 40", 41", 43", 46", 48", 50", 51", 54", 60", 66", 72", 84", 90", 96" and 108" diameter of shell.
1226—50" Colliau Cupola with No. 4 Roots Blower on bed plate with vertical engine, complete with elevator.
1219—51" Calumet Cupola, with ABC Blower, piping and fire brick, complete.
1223—58" Colliau Cupola with No. 4 Green Blower, piping and fire brick, complete.
1235—58" Colliau Cupola with Buffalo Blower, elevator and piping, complete.

BLOWERS

BUFFALO—Nos. 1, 3, 4, 5, 6, 7, 8, 9 and 11.
STURTEVANT—Nos. 3, 4, 5, 6, 7, 8 and 9.
AMERICAN—Nos. 6, 8 and 10.
CHAMPION—No. 8.
BOSTON—63".
ROOTS—Nos. ½, 2, 3, 4, 5, 5½, 6 and 7.
GREEN—Nos. 3, 4, 5, 5A, 6A, 6B, 7 and 8.
BAKER—Nos. 3, 4½, 5 and 7½.
CONNERSVILLE—3.3, 6, 12.75 and 60 cu. ft.

LADLES

1215—3½ ton Worm Geared Ladle.
1201—4 ton Spur Geared Ladle.
1256—5 ton Worm Geared Ladle.
1005—15 ton Spur Geared Ladle.
744—15 ton Worm Geared Ladle.
744—20 ton Worm Geared Ladle.
1153—1500 lb. Crane Ladle with shank.
1012—3000 lb. Crane Ladle with shank.
957—2000 lb. Teapot Spout Ladle.
1153—2 ton Worm Geared Reservoir Ladle.
1130—800 lb. 3 wheel Dirigible Buggy Ladle.

JIB CRANES

1147—Four Wall Jib Cranes, complete with trolleys and 1,000 lb. Harrington Hoists.
1147—Three Wall Jib Cranes, complete with trolleys and 1,000 lb. Harrington Hoists, each 13′ long.
1153—Two 2 ton Jib Cranes, 20′ mast, 20′ jib.
1153—One 3 ton Jib Crane, 20′ mast, 20′ jib.
1153—One 5 ton Jib Crane, 20′ mast, 24′ jib.
961—One 2 ton Jib Crane, 17′ mast, 21′ jib, equipped with one ton Sprague Electric Hoist, 110 volts D.C.
860—Twelve 2½ ton Jib Cranes.
1144—Two 2½ ton Shaw Wall Cranes, each have two 7½ H.P. enclosed type motors, 480 R.P.M.
1038—One 3 ton Wood Jib Crane, 25′ mast, 24′ jib.
1038—One 5 ton Wood Jib Crane, 25′ mast, 24′ jib.
1188—One 5 ton Jib Crane, counterbalanced, 30′ swing.
933—One 5 ton Pneumatic, Jib Crane, swing 13′1¼".
1003—Two 5 ton Niles Steel, 18′ 10" mast, 19′ 9" jib.
1121—Two 15 ton Triple Underbraced Steel Jib Cranes, power hoist and rack, mast 22′ 4", jib 17′, 7½ H.P. motors, 440 volts, 60 cycles, 3 phase A.C.
853—One 15 ton Whiting Steel Triple Underbraced 26′ mast, 26′ jib, motor operated without motor.

HAND TRAVELING CRANES

1178—Single "I" beam crane, 22′ span; without hoist; bridge and trolley geared; 210′ track and supports.
894—1,000 lb. capacity, 10′ span, with 15′ track.
744—2 ton Whiting, 17′ span, with hoist mechanism and bridge travel gearing.
1098—2 ton, 20′ span, Y.&T. chain hoist, 38′ of track.
1152—3 ton, 25′ span, with trolley, no hoist.
1150—5 ton Reading, 18′ span.
1060—5 ton single "I" beam, 23′ span, hoist has differential chain and winding drum; trolley travels on bridge but bridge is stationary and does not travel on rails.
1255—6 ton Whiting, 11′ 1½" span.
1122—10 ton Crane Bridge, 38′ 8" span, without trolley.
1070—15 ton Box, span 48′ 8", drum type control.
1188—20 ton. 55′ span, two carriages.
1174—35 ton, 33′ 2" span, no hoist or trolley.
990—Lot of 5 ton Steel Plate "1" Beam Trolleys, roller bearing.

ELECTRIC TRAVELING CRANES

1055—2½ ton Cleveland, 18′ span, 2 motors, 220 volts D.C., with 320′ of runway.
1225—3 ton P.&.H., 39′ 2" span 3 motors, 220 volts D.C.
1253—3 ton, 33′ span, 3 motors, 220 volts, A.C.
744—5 ton General, 29′ span, 3 motors, 110 volts D.C.
1174—5 ton, 27′ span, floor control. Trolley and bridge hand operated; hoist 5 ton Y.&T. Electric, 220 volts, 3 phase, 60 cycles.
1214—5 ton Case, 47′ span, 3 motors, 220 volts D.C.
744—10 ton Whiting, 24′ span, 3 motors, 110 volts D.C.
1126—10 ton Whiting, 48′ 8" span, 2 motors, 220 D.C.
1150—10 ton Toledo, 30′ span, 3 motors, 220 volts D.C.
1225—15 ton P.&H., 39′ 2" span, 3 motors, 220 volts D.C.
1070—20 ton Sellers, 47′ span, any current.
965—5 ton Whiting Pneumatic, 36′ span.

HOISTS

1017—Curtis class "G" Air Hoist, 4" cylinder, 4′ stroke.
1103—Two 1 ton Ingersoll-Rand Air Hoists.
744—1½ ton Mono Rail Hoist, 2 motors, 220 volts D.C.
744—4 ton Mono Rail Hoist, 220 volts D.C.
1254—6 ton Y.&T. Triplex Chain Hoist.

MOLDING MACHINES

1212—Fifteen Adams 30" Portable Squeezers.
959—Ten Cleveland Wall Squeezers, 26" x 16" flask.
965—Model "E" Berkshire Hand Squeezer.
969—Four Reynolds Hand Squeezers, 25".
900—Farwell Hand Squeezer, 18 x 24.
1224—30" Adams Stationary Squeezer.
1074—38" Farwell Portable Squeezer.
856—60" Adams Portable Universal.
934—30" Tabor Air Squeezer.
774—Tabor Power Squeezer, 12" cylinder.
1087—Four No. 76-J Osborn Jolt Type Squeezers, 36"
827—3 Model "E" Berkshire Combination Squeezers.
1220—Three 42" type "H" International Power Squeezers, 16" cylinder.
1221—U. S. Combination Jar and Squeezer Molding Machine, No. 1 size, 5" jar cylinder, 12" squeeze cylinder.
933—Three Mumford Power Squeezers, table 18 x 26.
774—Mumford Squeezer, 36" between uprights, 14" cylinder, table 14 x 8.
933—Tabor Power Squeezer, table 18 x 26.
1221—No. 100 Osborn Plain Jolt Molding Machine.
965—24 x 30 Herman Plain Jarring Machine.
1206—Tabor Shockless Jarring Machine, 6" cylinder.
876—No. 62 Buch Electric Molding Machine, 220 D.C.
792—3" Osborn Baby Core Jolt Rammer, table 18"
1071—Tabor Plain Jarring Machine, 8" cylinder.
900—20" Tabor Plain Jarring Machine, table 60" x 72".
900—Two 10" Tabor Power Rammers.
900—Two 16" Tabor Power Rammers.
900—30 x 45 Herman Jarring Machine, 10" cylinder.
1161—Two 3" Mumford Jolt Rammers.
813—Lawler Jarring Machine, No. 23, 50 x 84.
1096—Model "A" Berkshire Automatic Molding Machine
1004—Two Berkshire Automatic Molding Machines.
1040—Tabor Molding Machine, split pattern, power squeezer, 3" hand draft, 10" cylinder, 14" x 16".
1154—60" Arm Gear Molding Machine, column 11" diameter, 6′ high, base 5′ x 12′, stroke on head 24", with index plates.
965—30 x 45 Herman Jar Roll-Over Molding Machine.
961—Twenty Pridmore Rock-Over Molding Machines.
1130—22" International type "R" Turn-Over Draw Machine, 8" draw.
1240—No. 2 Arcade Modern Molding Machine.
1266—30" Tabor Hinge Molding Machine, 12" draft.
1183—36" type "F" International Combination Jar Ramming, Power Turn-Over power draft Molding Machine, complete with heavy duty vibrator and special clamping rods, 8" draw.
1086—Tabor Power Roll-Over Molding Machine, 50" hinge, 20" roll-over cylinder, 24" draw, table 40" x 42".
1039—No. 402 Osborn Direct Draw Roll-Over Jolt Molding Machine.
1139—Osborn Roll-Over Draw Machine, 46" between rods, 10" lift, hand power.
888—Tabor Roll-Over Molding Machine, 5" draft.
776—Tabor 24" Roll-Over Molding Machine, 7" draw.
900—Two 18" Tabor Hinged Molding Machines.
737—No. 10 Osborn Rock-Over Jolt Molding Machine.
991—No. 1 Arcade Modern Molding Machine.
1230—Tabor Hand Molding Machine, for flasks 12" x 15".
900—30" Tabor Hinged Molding Machine, 12" cylinder.
801—18" Tabor Roll-Over Machine.
967—Two 24" Tabor Hinged Molding Machines.
967—Two 18" Tabor Hinged Molding Machines.
1231—30" Tabor Roll-Over Machine, 12" straight draft.
900—Two 32 x 36 Pridmore Stripping Plate Machines.
965—36" Pridmore Round Stripping Plate Machine.
911—Four Pridmore 10" x 12" Stripping Plate Machines.
1153—36" Pridmore Roll-Over Stripping Plate Machine.
1153—44 x 52 Pridmore Stripping Plate Machine.
1153—44 x 60 Pridmore Stripping Plate Machine.
965—52" Pridmore Round Stripping Plate Machine.
1263—Three Berkshire Hand Squeezers.

BRASS FURNACES

1195—42" Schwartz Furnace.
1194—60" Schwartz Furnace.
943—90" Schwartz Furnace.
1058—2000 lb. Electric Furnace.
CRUCIBLE FURNACES—all sizes from Nos. 20 to 275, for coal, coke gas or oil fuel, tilting or stationary type.

FLASKS

787—200 Berkshire Cast Iron Flasks, 10" x 12", 4½" cope, 4½" drag, taper in at parting line, 2 pins each end, weight 55 lbs. each—excellent for machine molding.
922—Sterling Steel Flasks, all with 2 pins in one end, one pin in the other end, with spout for end pouring.
  150—12" x 18", 4" cope, 4" drag, style "A".
  2—22" x 72", 6" cope, 6" drag, style "F".
  4—30" x 30", 7" cope, 7" drag, style "F".
  3—22" x 60", 6" cope, 6" drag, style "F".
1253—Sterling Steel Flasks, style "A", equipped with ¾" pins on 18" centers.
  100—12¾" x 15¼", 4" cope, 4" drag.
1263—Sterling Steel Flasks—last four sizes have holes for end pouring instead of handles.
  100—12" x 16", 3" cope, 3" drag, style "G".
  100—12" x 16", 4" cope, 4" drag, style "G".
  25—18" x 24", 5" cope, 5" drag, style "G".
  50—12" x 16", 4" cope, 4" drag, style "K".
  50—18" x 20", 5" cope, 5" drag, style "GK".
  25—12" x 16", 3" cope, 3" drag, style "H".
  25—12" x 16", 4" cope, 4" drag, style "H".
  25—14" x 16", 3" cope, 3" drag, style "H".
  25—14" x 16", 4" cope, 4" drag, style "H".

TUMBLING BARRELS

1252—One 24" x 48" Exhaust Tumbling Barrel, 7/16" shell.
1065—Two Square 30 x 30 x 48 Exhaust Tumbling Barrels, with countershaft, clutches and door cranes, ¾" thick.
1065—Two Square 18 x 18 x 48 Exhaust Tumbling Barrels, ½" thick, with counter-shaft, clutches and door cranes.
1098—24" x 32" Cast Iron Stave Tumbling Barrel.
979—Battery of 10 Cast Iron Stave Tumbling Barrels, 19½" diameter, 40" long, complete with shafts, couplings and driving rigging all mounted on heavy cast, iron bucks.
1138—Tilting Tumbling Barrel, wood, steel lined, 28" diameter opening, 32" diameter bottom of barrel, 26" deep
1050—Water Tumbling Barrel, 25" x 28", door 11" x 8½".
1263—Water Tumbling Barrel.

GRINDING PANS

1261—6′ Overgeared Grinding Pan, rolls 32" x 18".
1201—Two 8′ Grinding Pans, motor drive, rolls 66" x 11".
973—9′ Overgeared Grinding Pan.
1130—Wadsworth Universal Sand Mixing and Compounding Mill with riddle.

CONVERTERS

1067—3 ton Steel Converter, motor tilted, with No. 5 Roots direct motor driven Blower, all connected up, ready to operate.
987—Two 5 ton Steel Converters, complete.

SPRUE CUTTERS

1102—Foot Power Sprue Cutter.
1262—Waterbury-Farrel Power Sprue Cutter, cuts 11/16" square yellow brass.
1263—Shuster Power Sprue Cutter, cuts 1¼" square yellow brass.

SAWS

1102—Metal Band Saw, table 30" square.
1139—Wright Metal Band Saw, equipped with roller weight, feed table, vise attachment and outboard bearing for countershaft.
860—22" Newton Cold Saw, arranged for belt drive.
1094—Eight Williamson Metal Band Saws, capacity up to 10" round or 12" "1" beam.

CORE OVENS

1140—8—Core Ovens, each with 6 drawers, each drawer 5′ long, 3′ wide, 6" or 8" deep, bottom drawer 10" or 12" deep (steel work only—no brickwork included).
1198—Core Oven, 4 sections, 21′ 4" long, 9′ high, 8′ deep, each section 6′ long 3′ 8" wide. Two sections have 5 drawers in each three 6" high, one 12" and, one 18"; one section has 4 drawers, two 6" high, one 16" and one 12"; one section has 4 drawers, two 6" high, one 18" and one 10".

CARS

855—2 ton Core Oven Cars, 42" x 72", 23½" gauge.
1245—Sixty 3 ton Core Oven Cars, 64" x 38", 39" gauge.
1201—Eighteen Core Oven Cars, 14′ 9½" x 7′ 4½", 20" high, gauge 75".
1129—Nine 15 ton Core Oven Cars, 7′ x 7′, 45" gauge, 3 decks, all steel.
744—Seven Core Oven Cars, 34" x 90", 36" gauge, 12 racks 52" x 90" spaced 5¼" apart, rail to first deck 18".
1238—2½ cu. yd. Rocker Dump Car.
992—Two Steel Side Dump Cars, 1 cu. yd., 23½" gauge, 5′ long, 3′ wide, 2′ 2" deep.

SUNDRIES

1249—No. 2 Wadsworth Core Machine ⅜" to 3".
1263—No. 3 Wadsworth Improved Core Machine.
1263—Blystone Sand Mixer, 5 cu. ft. capacity.
1210—5 ton Basic O.H. Tilting Oil Burning Steel Furnace, complete with steel charging platform and stack.
965—Shuster Wire Straightening Machine, for straightening old, bent and twisted ½", ⅝", ¾" and ⅞".
1211—36" Cutler-Hammer Lifting Magnet, 220 D.C.
1220—36" Lifting Magnet, with lifting drum, cable and motor-generator set.
1263—Core Lathe, for shaping cores.
1229—1000 lb. Victor Platform Scale, portable, 17" x 26".
1113—2000 lb. Howe Portable Platform Scale, 21" x 30".
888—Two No. 4B Keller Pneumatic Bench Rammers.
1228—⅜" Murphy Pistol Sprayer.
1144—Ten Riehle Rope Machines.
934—Five Hanna Tripod Air Sifters for 18" riddles.

J. S. McCORMICK COMPANY, Pittsburgh, Pa.

Index to Advertisements

A
Abell-Howe Co. 105
Abrasive Co. 69
Adams Co. 32, 33
Ajax Metal Co. 161
Alden Coal Mining Co. 142
American Boron Products Co., Inc. 90
American Clay Machinery Co. 55
American Foundry Equipment Co. 27, 62, 63
American Gum Products Co. 7
American Molding Machine Co. 48
American Oil Refining Co., Inc. 8
Amer. Zinc, Lead & Smelting Co. 159
Arcade Mfg. Co. 43
Asbury, Graphite Mills 153
Atlas Car & Mfg. Co. 133

B
B. & B. Mfg. Co., Inc. 44
Barnett, Oscar, Foundry Co. 171
Basic Mineral Co. 88
Berkshire Mfg. Co. 36
Bernstein Mfg. Co. 127
Betton, J. M. 142
Biehl Iron Works, Inc. 106
Birkenstein, S., & Sons 161
Black Products Co. 152
Blackwell, Geo. G., Sons & Co., Ltd. 160
Bloomsbury Graphite Mills 26
Blount, J. G., Co. 141
Blystone Mfg. Co. 57
Brennan Boot & Shoe Co. 151
Brosius, Edgar E. 134
Brown Hoisting Machinery Co. 107
Brown Specialty Machinery Co. Front Cover
Buckeye Products Co. 125

C
Canada Carbide Sales Co. 152
Cape May Sand Co. 147
Carborundum Co., The 70
Cataract Refining & Mfg. Co. 10
Central Foundry Supply Co. 139
Champion Foundry Machine Co. 59
Charcoal Iron Co. of America 91
Chase, Frank D. 102
Chesapeake Iron Works 132
Chicago Pneumatic Tool Co. 115
Chisholm & Moore Mfg. Co. 135
Clarage Fan Co. 136
Clark Cast Steel Cement Co. 125
Clark, Charles J. 136
Cleveland Blow Pipe & Mfg. Co. 143
Cleveland Nickel Works 75
Cleveland Pneumatic Tool Co. 138
Coburn Trolley Track Mfg. Co. 108
Columbian Facing Mills Co., Inc. 151
Combined Supply & Equipment Co., Inc. 129
Connersville Blower Co. 136
Cooper, H. W., Saddlery Hardware Mfg. Co. 38
Co-Operative Engineering Co., Inc. 83
Corn Products Refining Co. 19
Courtney-Fraser Co., Inc. 162
Crucible Co., The, of New Jersey 156
Curtis Pneumatic Machinery Co. 137

D
Damascus Bronze Co. 160
Davenport Machine & Foundry Co. 46
Davis-Bournonville Co. 87
Dayton Pneumatic Tool Co. 140
Debevoise-Anderson Co. 158
Decatur Malleable Iron Co. 156
Delevan Mfg. Co. 162
Demmler, Wm., & Bros. 153
Detroit Testing Laboratories 162
Diamond Clamp & Flask Co. 51
Dings Magnetic Separator Co. 74
Dixon, Joseph, Crucible Co. 130
Dobson, Wm. 146
Dunning, W. D. 149

E
Eastern Brass & Ingot Corp. 85

F
Fanner Mfg. Co. 171
Federal Foundry Supply Co. 22
Federal Malleable Co. 45
Foreign Crucibles, Corp., Ltd. 156
Foundry Equipment Co. 79
Foundry Manganese Co. 159
Frost Mfg. Co. 148

G
Gautier, J. H., & Co. 131
Geauga Silica Sand Co., The 150
General Briquetting Co. 159
General Electric Co. 101
General Platers' Supply Co., Inc. 157
Globe Steel Co. 146
Goldschmidt Thermit Co. 123
Gordon Sand Co., Inc. 150
Great Western Mfg. Co. 58
Greene, Albert E. 146
Gulick-Henderson Co. 162

H
Hall-Holmes Mfg. Co. 150
Hamilton & Hansell 152
Hampden Corundum Wheel Co. 141
Hanna, M. A., & Co. 159
Harrison Supply Co. 147
Hawley Down Draft Furnace Co. 156
Hay's, Samuel W., Sons 142
Hayward Co. 134
Herman Pneumatic Machine Co. 47
Hill-Brunner Foundry Supply Co. 18
Hill & Griffith Co. 9
Hillman, J. H., & Sons Co. 162
Hoevel Mfg. Corp. 145
Hohlfelder, F., Co. 75
Hooper-Falkenau Engineering Co. 104
Hoosier Clay Products Co. 158
Horstmann, Wm. H., Co. 125
Hunt, C. W., Co., Inc. 135

I
Iler Co., The 157
Illinois Clay Products Co. 156
Illinois Mfg. & Supply Co. 77
Industrial Electric Furnace Co. 96
Independent Pneumatic Tool Co. 141
Ingersoll-Rand Co. 73
International Clay Machinery Co. 148
International Molding Mach. Co. 28, 29
International Oxygen Co. 155
International Pulp Co. 121

J
Jelliff, C. O., Mfg. Corp. 150
Johnson, William 121

K
Kawin, Charles C., Co. 163
Keener, Sand & Clay Co., The 148
Keep, W. J. 142
Keller Pneumatic Tool Co. 68, 142, 150
Kelly, T. P., & Co., Inc. 11
King, Julius, Optical Co. 139
Knickerbocker Co., The 71

L
Lavino, E. J., Co. 158
Lincoln Electric Co. 2
Linde Air Products Co. 119
Lindsay, W. W., & Co., Inc. 53
Ludlum Electric Furnace Corp. 99
Lupton's, David, Sons Co. 103

M
McCormick, J. S., Co. 24, 169
McCullough-Dalzell Crucible Co. 94
McKeefrey & Co. 162
McLain's System, Inc. 97
MacLeod Co. 66
Magnetic Mfg. Co. 76
Malleable Iron Fittings Co. 130
Manning, Maxwell & Moore, Inc. 133
Mfg. Equipment & Engineering Co. 151
Marshall, F. W., & Co. 156
Mathews Gravity Carrier Co. 135
Matlack Coal & Iron Corp. 162
Maurer, Henry, & Son 158
Midland Machine Co. 34, 35
Milburn, The Alexander Co. 154
Millett Core Oven Co. 153
Mohr, J. J., & Son 162
Moltrup Steel Products Co. 49
Monarch Engineering & Mfg. Co. 98
Moore, W. E., & Co. 162
Mott Sand-Blast Mfg. Co., Inc. 65
Multi-Metal Separating Screen Co. 146
Mumford, E. H., Co. 41
Mumford Molding Machine Co. 37

N
National Engineering Co. 148
National Smelting Co. 115
New Chicago Crucible Co. 95
New Haven Sand Blast Co. 145
New Jersey Zinc Co. 131
Niles-Bement-Pond Co. 133
Northern Engineering Works 132
Norton Co. 144

O
Obermayer, S., Co. 23
Ohio Blower Co. 131
Oldham, Geo., & Son Co. 138
One Piece Chaplet Works 123
Osborn Mfg. Co. 39
Oxweld Acetylene Co. 86

P
Pangborn Corp. 64
Pawling & Harnischfeger Co. 110
Paxson, J. W., Co. 4, 5, 174
Peck Iron & Steel Works 52
Peekskill Fire Brick Works 158
Pettinos Bros. 60
Philadelphia Chaplet & Mfg. Co. 171
Phillips & McLaren Co. 148
Pickands, Mather & Co. 162
Pilling & Crane 162
Pittsburgh Crushed Steel Co. 144
Pittsburgh Pneumatic Co. 72
Pittsburgh Shovel Co. 128
Portage Silica Co. 61
Powell, Wm., Co., The 154
Pressed Steel Co., The 54
Prest-O-Lite Co., Inc., The 155
Pridmore, Henry E. 30, 31
Primos Chemical Co. 160

Q
Quigley Furnace Specialties Co. 100

R
Randall Tramrail Co. 134
Ridgway, Craig & Son Co. 121
Robeson Process Co. 13
Rogers, Brown & Co. 158
Roots, P. H., & F. M., Co. 82

S
Safety Emery Wheel Co. 143
Sand Mixing Machine Co., Inc. 27, 62, 63
Saunders & Franklin 162
Scully-Jones & Co. 109
Seligman, Arthur 161
Sellers, Wm., & Co., Inc. 149
Shaw Electric Crane Co. 126
Shepard Electric Crane & Hoist Co. 111
Shore Instrument & Mfg. Co. 156
Shuster, F. B., Co. 140
Sly, W. W., Mfg. Co. 80, 81
Smith, Werner G., Co. 6
Smooth-On Mfg. Co. 93
Sprague Electric Works of Gen. Elec. Co. 134
Standard Equipment Co. 150
Standard Sand & Machine Co. 117
Stein-Hirsh & Co. 152
Sterling Grinding Wheel Co., The 138
Sterling Oil Corp. 153
Sterling Wheelbarrow Co. 50
Stevens, Frederic B. 173
Stow Mfg. Co. 140
Strong, Kennard & Nutt Co. 127
Sugar Products Co., Inc. 152
Sullivan Machinery Co. 137
Superior Sand Co. 150
Swan & Finch 20, 21

T
Tabor Mfg. Co. 40
Tessmer Machine & Tool Co. 123
Tilghman-Brooksbank Sandblast Co. 146
Titanium Alloy Mfg. Co. 89
Toledo Bridge & Crane Co. 135
Tropenas Converter Co. 156

U
United Compound Co. 151
U. S. Chaplet & Supply Co. 127
United States Alloys Corp. 160
United States Graphite Co. 12
U. S. Molding Machine Co. 42
United States Silica Co. 67

V
Vesuvius Crucible Co. 157
Vulcan Engineering Sales Co. 37, 78

W
Wadsworth Core Machine & Equip. Co. 25
Wagner Fire Brick Co. 158
Wenger, Paul, & Co. 160
Western Tool & Mfg. Co. 171
Wheeler & Holcomb Co. 129
Whipple & Choate 160
White & Bro., Inc. 161
Whitehead Bros. Co. 3
Whiting Foundry Equipment Co. 112, 113
Wonham Bates & Goode, Inc. 128
Wood. T. B., Sons Co. 115
Woodison, E. J., Co. 14, 15, 16, 17
Worthing Pump & Mach. Corp. 56

Y
Yale & Towne Mfg. Co. 135

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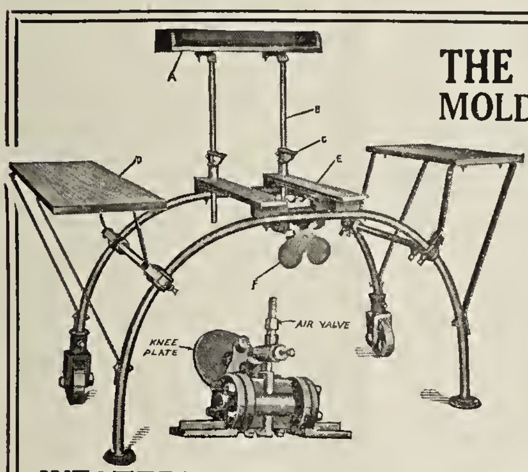

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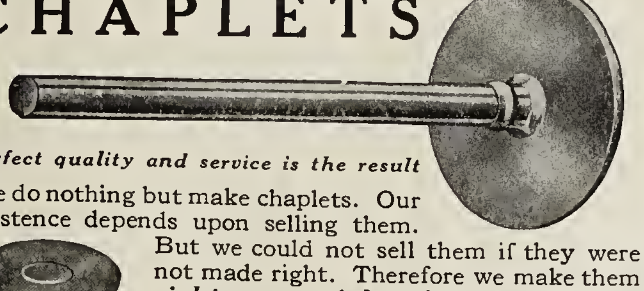

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16

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